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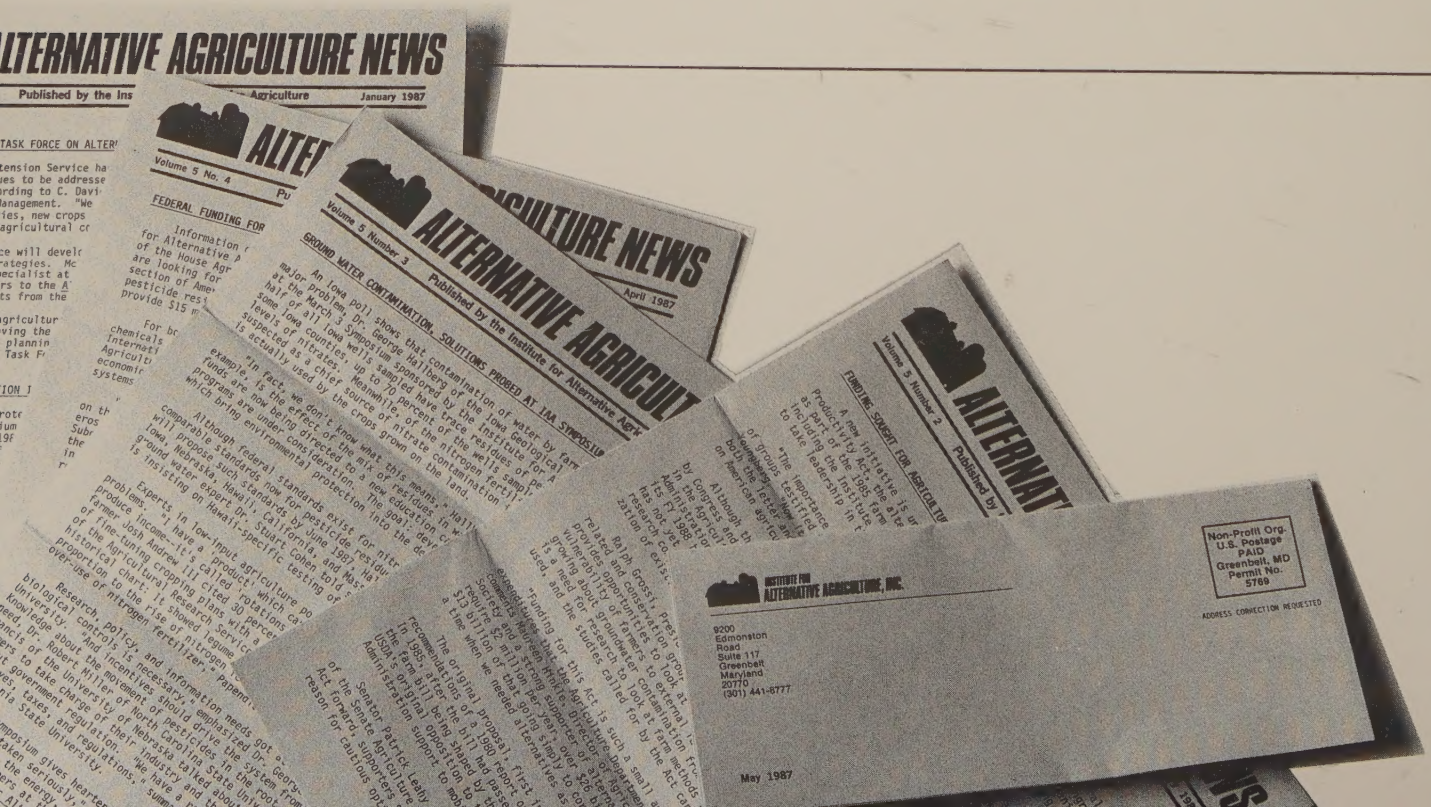

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Institute Information

The Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of low-cost, resource-conserving and environmentally-sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system.

Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a grass roots Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

Northeast Nebraska farmer Bob Warrick describes his integrated crop/livestock operation to sustainable agriculture tour participants; this tour has visited alternative enterprises and innovative farmers each summer in Nebraska for the past ten years. Photo by Dr. Charles A. Francis, Professor of Agronomy and Extension Crop Specialist, University of Nebraska, Lincoln, NE.

Learning from Each Other: New Models for Sustainable Agriculture Research and Information

Over the past several years, more and more agriculturalists have come to acknowledge, embrace, and articulate the importance of agricultural sustainability as a critical goal for U.S. agriculture. While the logic of this position seems undeniable (it is difficult, after all, to imagine how anyone could favor an unsustainable agriculture), the increased attention during the 1980's to the concept of sustainability, nonetheless, has fostered considerable controversy.

The view that current approaches are not sustainable for the long term has placed many within the conventional agricultural community on the defensive. Whether they be researchers, educators, farmers, policymakers, or members of agricultural industry, those who have contributed to the development and adoption of chemical- and energy-intensive production systems are, understandably, disquieted over the negative critique of those technologies implied by the increasing emphasis on agricultural sustainability.

While this anxiety tends to pervade all sectors of conventional agriculture, debate over the nature of agricultural sustainability has been particularly evident within the agricultural research and education community, including its administrative and policymaking elements. As interest in sustainable agriculture techniques and systems has grown, so has the level of uncertainty over how best to identify, define, describe, structure, prioritize, fund, and administer a sustainable agriculture research and education program.

In part, the difficulty of developing such an agenda stems from genuine disagreement over the nature and properties of agricultural sustainability. Indeed, the relative absence of objective indicators of sustainability illustrates, somewhat paradoxically, the inherent complexity of developing a sustainable agriculture research and education agenda in the U.S.: It is difficult to draw a road map or select a mode of transportation without knowing where you wish to go or need to be. A major collaborative effort involving the full range of agricultural disciplines, as well as some outside the traditional boundaries, will be required in order to address this broad and fundamental need for better indicators of agricultural sustainability.

Garth Youngberg and Richard J. Sauer
Symposium Co-Chairs

Meanwhile, despite these and other unresolved issues, interes in sustainable agriculture research and education continues t mount. This interest is marked by a number of general trends specific initiatives, and widely shared assumptions about th character of sustainable agriculture research and education. In deed, most proponents of sustainable agriculture share the viev that the character of sustainable systems, particularly thei unique biological and human complexities and interactions, re quire new, innovative, interdisciplinary, and much more partici patory research and education programs and approaches.

For example, many favor more direct farmer involvement i the planning and conduct of research, more on-farm interdisci plinary research, more whole-farm and site-specific analyses more use of model farms and regional and farm-level ecosysten investigations, more applied research, and more socio-economi and farm structure analyses. Greater collaboration and use o authentic participative arrangements among all partie involved--researchers, educators, and farmers--are also critica and ubiquitous themes.

These and other beliefs and operating principles have mani fested themselves in some very exciting recent institutional de velopments. A plethora of farmer-based research and demon stration organizations, nonprofit groups, and universities is nov beginning to conduct collaborative sustainable agriculture re search. Such groups as the Practical Farmers of Iowa (PFI) a pioneer in the development of scientifically sound, on-farn research, have been instrumental in fostering such work. US DA's Low-Input/Sustainable Agriculture (LISA) program first funded in 1988, has provided a much needed organizationa and financial impetus for these kinds of programs. Increase funding of nonprofit, grass-roots sustainable agriculture organ zations and university-based programs by an increasingly con cerned foundation community has also been a critical factor i the growth of sustainable agriculture research and educatio initiatives.

Despite these efforts to find better ways to "learn from eac other," many important issues and questions remain either unre solved or unaddressed. It was within this context that the Insti tute for Alternative Agriculture convened its March 6, 199(symposium entitled "Learning From Each Other: New Model for Sustainable Agriculture Research and Information." Th

Continued on page 16

The meaning and benefits of partnership in agricultural research: Past successes--future potentials

Roland Bunch

Abstract. *Poor and often illiterate villager farmers in Central America have been taught by World Neighbors programs to (a) establish and manage simple agricultural experiments with one variable, (b) measure accurately the results, and (c) report the results to the program and each other. The impact on the areas' yields of the technology thus generated, validated, spread, and/or locally adapted, has been significant. Although the situation there differs from that of the United States, and therefore the experimental design would differ, many of the principles and advantages of such a system would probably also apply in North America.*

Key words: research, farmer-managed research, Central America

Introduction

A strikingly new methodology for agricultural research is gradually emerging in a series of Third World countries. Some people call it Participatory Research; Robert Chambers, the Director of the Institute for Developmental Studies at Sussex University, calls it the Farmer First approach. But whatever the name it eventually carries and form or forms it takes, some of us believe this new methodology could have tremendous impact on the productivity of the poorest farmers of the Third World.

I would like first to describe briefly the nature of this methodology, the setting in which it is being developed, the results it has achieved, and some of what we in World Neighbors have learned so far in its development and use. Then I would like to list a number of suggestions that might be useful in trying out and developing a similar system of research here in the United States.

World Neighbors' experience in the Third World

World Neighbors works with farmers who are often illiterate and seldom have a sixth grade education. These farmers usually own less than 10 acres of land, which is often highly marginal. It may consist of steep, heavily eroded mountainsides, semi-arid lands with no possibilities of irrigation, or waterlogged, infertile fields carved out of some erstwhile rainforest.

Yet after some twenty-five years of experience, we are finding that, in spite of these farmers' unpromising situations, yield increases can be significant. In an area of east-central Haiti, desperately low initial yields have been raised to an average of six times previous levels. In Guatemala, previously eroded hillsides with over a 25 percent slope now produce sustainable yields about half those of the United States. Similar slopes with virtually no topsoil in Honduras have produced up to 70 bu/A of corn their first year of rehabilitation. Villager farmers on the mountainous north coast of Honduras, by intercropping velvetbean and corn, may have the lowest per bushel corn production costs in the world.

Of course, in each case, some of the technology was brought from the outside. But also, in each case, local, illiterate, or barely literate farmers originated or adapted some or most of the technology involved. The case of intercropped velvetbean (*Mucuna pruriens* or *Stizolobium* spp.) is particularly interesting. Sometime in the 1950's, agricultural extensionists introduced velvetbean to farmers in northern Honduras. In many areas, the velvetbean died out. But around the town of Omoa, some twenty villages have developed a system of intercropping velvetbean with corn. After the first corn harvest, they cut everything down and injection plant their second season corn crop through the resulting six to eight inches of mulch. Around La Ceiba, where rainfall is heavier, the hillsides are steep, and only one crop of corn per year is possible, farmers are letting the velvetbean grow over and protect their land during the rainiest part of the year. When the velvetbean dies in December, they plant their corn and velvetbean with a dibble stick. Using this no-till system, one farmer can produce 400 bus. of corn on the average 9 acres year after year with no fertilizer costs, no machinery, a single herbicide application, and less than four months of his own labor (which other farmers there sell for between U.S. $2.00 and $3.00/

Presented at Institute for Alternative Agriculture Symposium entitled "Learning from Each Other: New Models for Sustainable Agriculture Research and Information," March 6, 1990, Washington, DC.

Roland Bunch is Area Representative for Central America, Mexico, and Haiti, World Neighbors, Honduras, C.A.

day).

After investigating these systems, World Neighbors began working with approximately 500 farmers in the Honduran highlands to investigate possibilities of similar systems. As a result, farmers have developed ways of managing the velvetbean in these climates so that it can be planted simultaneously with corn and cut twice to afford good weed control and maximum biomass production. Villagers have also checked out the intercropping of jackbean (*Canavalia ensiformis*) and lablab bean (*Dolichos lablab*) and have established under what conditions these legumes are preferable. They have collected and tried out seeds of another 15 species of legumes from jungles, forests, and fields, thereby discovering several other promising legumes. They have compared the incorporation of velvetbean into soil with the use of it as a mulch and have begun to learn in which ecological areas and farming systems each method is most advantageous. They have provided at least preliminary evidence that plants fertilized with green manures withstand drought much better than those fertilized with either chemical fertilizer or animal manure, a fact that could be very important in the Sahel and other droughty areas of the world. And they have discovered many other important ideas, such as some fifteen different recipes for using the 23 percent protein, high-lysine velvetbean for human consumption.

How was all this research brought about?

1. We taught villagers how to do very simple experiments, changing only one variable at a time, and weighing and measuring the results.

2. Where the villagers were totally illiterate, we either taught them to read or showed them how to keep simple farm records just by using numbers and dra
ings for each operation or input.

3. We taught them how to share th
results with each other.

4. The increases in yields th
achieved through their first heavily s
pervised experiments motivated them
continue experimenting.

5. By incorporating the new techn
ogy into our own technology packag
(thereby giving it worth), as well as gi
ing farmers some general ideas as to ne
avenues of research that might be usefu
we helped farmers new to the process
become involved and begin to discov
their own creative abilities.

And what have we learned from these experiences?

1. Villager farmers, even illitera
ones, can and will experiment with ne
technologies.

Velvetbean foliage adds tremendous quantities of organic matter to the soil. This organic matter releases minerals and nutrients into the soil which increase soil fertility.

Farmers can experiment with new ideas. For example, farmers have discovered that using the A-frame to make contour rows on steep fields can slow the erosion of soil from their fields.

2. Once trained, villagers are capable of developing new technology and carrying out a wide range of important and accurate adaptive research.

3. Villagers can be trained to teach each other and share effectively what they have learned with others.

4. Sustainable or low-input agriculture is much more location specific than high-input, capital-intensive agriculture and therefore requires more adaptive research. The only way we can do all the research necessary to provide good technology for the various and changing microclimates, microenvironments, and farming systems with which we work is to have thousands of experiments going on simultaneously in each country.

5. By training and motivating villager farmers to experiment, we can very likely meet this challenge.

Possible application in the United States

Having lived outside the United States for nearly all of the last twenty-three years, I am not the person to judge what will work here or what modifications would have to be made in this system to adapt it to conditions in the United States. Nevertheless, I would like to make some very tentative comments about why this line of action might be very worthwhile. I also offer a few ideas for steps that could be taken to test it and to begin to apply it if it looks promising.

First, there are several advantages to this kind of research. Technology developed by farmers on farmers' fields will often have more credibility than that developed by researchers on experiment stations. Thus, the resulting technology tends to be adopted more widely and more rapidly. The increased contact between researchers and farmers will improve the communication between the two and help keep the researchers' priorities closer to those of the farmer. The costs to research institutions of farmer-run research will be significantly less than that of experiment station research, even if significant incentives are given to participating farmers. Most importantly, the total amount of research done could be increased dramatically. Since sustainable agriculture has fewer commercial possibilities to exploit (thereby reducing the financial resources available for research) and is more location specific than high-input agriculture, these last two advantages are of particular importance.

But how much of what we are doing overseas is applicable in the United States? Certainly the standards used here for agricultural research are much more stringent than those we use. Since the differences in yields between treatments we are working with are often between 40 and 100 percent, we usually do not have to make many repetitions in order to be reasonably sure of our results. But

at the same time that research methods are necessarily more complicated here, the educational level of farmers is far superior to that of our farmers. I find it hard to believe (as some researchers maintain) that just a small amount of training in experimental theory and practice would not be enough to allow most North American farmers to analyze their results in a way that meets experiment station statistical standards.

In the Third World, we face a tremendous lack of research suitable for villager farmers. Government research budgets are being cut, most of the little money available is spent on research for plantation export crops rather than for the poorer people's subsistence and food crops, and the quality of what little research is done for small holders is very questionable. Thus, we've been forced to rely on the farmers themselves. The research establishment in the United States is obviously far superior to that in the Third World, yet farmers would very likely still have an important role to play. They could multiply many times over the number of experiments being done and work at adapting basic research to a much larger variety of farming systems and economic and ecological environments. Farmers would understand their own situations and problems better than do researchers, so the new technologies they developed and adaptations they tried would tend to be more relevant to farmers' needs. Last, if barely literate villagers can develop surprisingly original innovations, certainly among American farmers there must exist a large but mostly untapped source of creativity and new ideas.

What could be done, then, in the United States to move toward a more participatory research approach?

First, much more study is needed of how American farmers can do research. For instance, farmer-managed research may have to be done using farm equipment; plots may have to be much larger than those scientists have traditionally used; and, in some cases, the necessary replications will have to be spread among various farms (Rzewnicki et al., 1988). There will inevitably be a good deal of trial and error, but in time, statistically acceptable research methods suitable to farmer management surely can be developed.

Once these methods have been thoroughly tested, training programs for farmers could be developed and carried out. Manuals explaining the farmer-adapted research methods and their statistical basis could be written in non-technical language. The objectives of professional researchers could be changed to include working together with farmers to assist them in carrying out farmer-managed research. Perhaps incentives could be set up to motivate farmers to become involved in research and to motivate researchers to work along with farmers. Perhaps a system of awards could be set up for the most widely adopted, ecologically beneficial technologies developed by farmers.

As far as possible, the research done by farmers should receive the same attention and be valued as highly as equally useful research done by professionals. This means that farmers' research should be included in conferences on new technology. Field days should be organized for farmers to see each others' results. Either established journals should include articles on this technology or specialized journals could be developed to report on these findings.

There is, of course, and there will be a certain amount of resistance among some professional researchers and their institutions to the spread and legitimization of farmer-run research. In the Third World, we have seen doctors' resistance to the advent of the so-called "barefoot doctors" or village health workers. Agronomists in some countries have moved to outlaw farmer-to-farmer extension programs. Nevertheless, if farmer-managed research proves to be a useful and efficient complement to research managed by professionals, it behooves the United States' farmers to make it work.

If Honduran villagers are producing cheaper corn than Midwest farmers, I think we can say with some confidence that the day is upon us when the United States' agriculture, just like its industry, can no longer afford to coast along usir less efficient methods than those of i foreign competitors.

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Two new alternative agriculture organizations formed

Two new alternative agriculture organizations have been formed and are welcoming new members.

--The **International Ecological Agriculture Trade Association (IEATA)**, based in Osco, Illinois, was organized to promote and encourage the use of ecologically sound agriculture worldwide. Members include manufacturers of any and all ecologically oriented products, technology developers or writers, consultants, producers, and other interested parties.

For more information about the Association, contact **IEATA**, 1365 N 800 East, Osco, IL 61274; (1-800-373-5971).

--The **Organic Grapes Into Wine Alliance (OGWA)**, based in San Francisco, California, was formed to promote the production of wine from organically grown grapes. It is made up of both small and large wineries, grape growers, wine retailers, wine importers and wholesalers, and supporting members from across North America. Originally formed as the California Organic Wine Alliance, the Alliance has adopted its own standards for organic wines based on the French organic wine standards developed in the 1960s.

For more information about the Alliance, contact **OGWA**, 54 Genoa Place, San Francisco, CA 94133; (1-800-477-0167).

Learning from each other: A look at how we do research

Robert H. Miller

Abstract. *The research agenda for agriculture remains an important concern for anyone interested in the future of sustainable agriculture. Differences in opinion remain on both prioritization of topics and on how and where the necessary research should be done. The inferences are that the research strategies of the 1960's and 70's were not appropriate. If we truly "learn from each other," we must consider what recent reports, models, and recommendations from written sources and individuals seem to be saying. Examination of these sources suggests a number of characteristics for the research that is needed: 1) Research which addresses problems regional in scope and which are often site specific; 2) research prioritization must involve a broader cross-section of opinions than ever before and include farmers, private non-profit organizations and scientists; 3) research must be more multidisciplinary and include farmers, extension faculty, and staff more directly; 4) systems research requires more emphasis and adoption for progress in many areas; 5) basic principles and theory for many agricultural disciplines will need examination and eventual modification; and 6) on-farm research is an essential part of the total research effort. The final obligation for all of us is a vigilance to assure that the research done is always of the highest quality.*

Key words: on-farm research, systems research, multidisciplinary research, sustainable agriculture research

In considering ways in which university researchers can learn from others to enhance sustainable agriculture, an important question is, "From whom do we learn?" In the past, this might have meant just our peers. Peer pressure in agricultural science is just like the pressure on teenagers to use drugs or buy expensive sneakers. This can be seen from the way agricultural research developed in the 1960s and 1970s, when U.S. farming was changing into what we currently call conventional agriculture. Most scientists went along with the prevailing production orientation, with only a few addressing environmental, social, and economic concerns. Yet these concerns are the very ones now responsible for the increasing national interest in a more sustainable agriculture. The "others" we learned from were ourselves.

From whom else can we learn in future research in sustainable agriculture? We can learn directly from individuals. In my case, these have included other people in this symposium. For example, from Dick and Sharon Thompson I have learned not to underestimate farmers as a source of new research ideas. They have shown that farmers and farm research networks can be effective in evaluating ideas and practices, resulting in sustainable technology that is farmer "friendly." From Chuck Francis I have learned much about farming systems research, about statistical methods suitable for large field on-farm research, and about focused, high-impact technology transfer materials for research results already available.

We must draw on many different individuals, reports, and programs as sources of the research approaches needed for the future evolution and success of sustainable agriculture. Three activities that I have been involved in and learned from are the Low-Input Sustainable Agriculture (LISA) Research and Education Program (U.S. Dept. of Agriculture, 1990), the Alternative Agriculture Report of the National Research Council (1989), and the International Conference on Sustainable Agricultural Systems (Edwards et al., 1988).

The LISA Program has provided a model of funding and operation that will have a great impact on U.S. agricultural research. It is based on several important principles. First, its technical review committees and funding are regional, which allows research approaches that are especially suitable for specific regions. The review committees are composed of university and USDA scientists, farmers, representatives of non-profit organizations, and extension faculty and staff. Moreover, preference is given to proposals that are interdisciplinary, that establish linkages among universities, private agencies, and extension, that involve farmers in a meaningful way, and that include economic analysis. Both the makeup of the review committees and the linkages required in the projects result in a much wider array of talent, ideas, and approaches. This has always been an ideal, but seldom has it been fulfilled.

The NRC Committee pointed out problems that must be corrected for a research program on sustainable agriculture to be successful. Basic, discipline-

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Robert H. Miller is Dean, College of Resource Development, University of Rhode Island, Kingston, RI 02881.

oriented research often is ineffective in solving major agricultural problems, yet many states have lost the ability to carry out applied research. Second, we have inadequate knowledge of the economic, environmental, and social costs of current and alternative agricultural systems. Third, although long-term systems research is essential, current funding for it is inadequate; moreover, researchers may face problems in getting promotions and tenure if their work has been long term or multidisciplinary. Finally, sustainable agriculture needs to capitalize on the great potential benefits of biotechnology.

At the International Conference on Sustainable Agricultural Systems, a workshop developed several recommendations that are relevant here. More emphasis should be given to system research on whole farms and watersheds. On-farm research should be an important part of the effort because it tells whether the technology is "friendly" to the farmer and farm family and how its success is related to the individual's management skills. The workshop also noted that basic principles and theory in many agricultural disciplines will have to be modified to deal with sustainable agriculture.

I would like to add to these recommendations some ideas I have acquired from participating in other dialogues and conferences going back almost a decade. First, a warning. I am concerned that the new and exciting research paradigms of sustainable agriculture avoid becoming rigid and dogmatic. I have already seen new, original ideas rejected because a new establishment sees them as irrelevant. Let us not risk creating a narrow, sterile research base in the future. Also, despite the problems caused by overemphasis on reductionist, component-oriented research during the past few decades, some component research is important to sustainable agriculture. If it is not funded, our reservoir of scientific knowledge will be depleted. Examples of specific topics that deserve additional study include allelopathic mechanisms, genetic improvement of legume cover crops, and a better understanding of the plant rhizosphere and weed biology. Finally, everyone involved in sustainable agriculture has an obligation to remain vigilant to insure that research is always of the highest quality.

I have summarized recommendations and ideas gathered from many sources. If they are heeded, future sustainable agricultural research in which we all continue to learn from each other will b exciting and rewarding.

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Nationwide campaign urges restoration of farm bill provisions

Many organizations around the country, including the IAA, are working to restore key proposals that were included in the 1990 Farm Bill but have been contradicted by recently issued regulations. Those organizations are particularly concerned with the lack of proper implementation of the Integrated Farm Management Program Option (IFMPO) and are requesting the reinstatement of the farmer's option to harvest small grains, other than barley, oats, and wheat, that are part of a resource-conserving crop on set-aside (ACR) acreage.

The IAA and others are also urging a restoration of the IFMPO provision which allows participants to hay or graze up to 50 percent of ACR acreage year-round without restriction; to change the acreage goal to five million acres per year, or up to 25 million acres over the life of the farm bill; to clarify the proposed criteria for ranking applicants, in order to eliminate criteria based on highly erodible land or on educational or demonstration value; and to allow producers who so choose to enroll a particular crop acreage base or bases, without necessarily enrolling all crop acreage base.

EPA permits continued use of some chemicals

The Environmental Protection Agency has allowed the continued use of agricultural chemicals that get into processed foods and that pose no more than a one-in-one-million risk of cancer over a lifetime of regular consumption. The decision continues to bypass a 37-year-old federal ban on allowing concentrations of carcinogenic chemicals in processed foods greater than those on the raw farm products, the so-called Delaney Clause. In this ruling, EPA applied a "negligible risk" standard to cancer-causing pesticides and other farm chemicals that concentrate in almost any food products that are canned, frozen, cooked, or otherwise processed before sale. Several groups had petitioned EPA to invoke the Delaney Clause, arguing that, if it were strictly implemented, all cancer-causing chemicals would be eliminated from the food supply and incentives would be created for the entry of safer alternatives.

Participatory strategies for information exchange

Charles Francis, James King, Jerry DeWitt, James Bushnell, and Leo Lucas

Abstract. *Complexity and rapid change in the agricultural industry are pushing us toward more participatory systems of information development and exchange. These changes are driven by a rapidly evolving information environment, with a multiplicity of sources and different clients, and by a technological revolution in communications equipment. At the same time, scientists and farmers are becoming increasingly aware of the complex biological interactions that occur in cropping systems and how these are connected with the overall ecosystem. We are expanding our time and space frame of reference. To address tomorrow's challenges, it will be important to blend the efforts in research and extension, to include farmers as full participants in the planning, execution, and interpretation of experiments, to explore new directions such as model farms and master farmers, and to develop creative educational approaches to encourage practical problem solving. Collaborative efforts of universities, industry, farmer groups, and environmental organizations will be needed to fully empower the individual farm manager to make rational and environmentally sound production decisions in the future.*

Key words: extension, communications, ecosystems, technology transfer, networking, demonstrations

Introduction: Why participatory strategies?

At this time in history, all the major protagonists involved with agriculture are being challenged, and even threatened, by the number and scope of the industry's transitions and changes. Reeling with the reality of the approaching 21st century, all agricultural groups confront a dynamic and unpredictable future. Complexity and change are pushing all of us toward participation. What are some of the changes that are affecting the major players?

Farmers and ranchers today are faced with a climate of unprecedented change. The climate includes substantial and sometimes unpredictable changes in costs and availability of inputs, in markets and prices for products, in government programs, and in regulations. Producers are also faced with an image problem. They are sometimes viewed as practitioners of a business that overuses or misuses chemicals and fertilizers to the detriment of public health and safety and the environment.

Industry now confronts a challenge from a skeptical public. Long recognized as an important contributor to crop and livestock productivity, the pesticide and fertilizer industry now is faced by a public perception that it contributes to environmental problems instead of solving problems. Industry research to produce a new generation of environmentally sound products and practices gets little publicity.

Environmental organizations have become increasingly concerned about nonpoint source pollution from agriculture. They are aggressively active in the political arena with regard to farm-related legislation. There is little general appreciation that farmers and ranchers live and work closer to the natural environnment than most who live in an urban setting. Producers have an immediate concern and involvement with their sources of drinking water, food produced at home, and exposure to products used in the operation of an agricultural business.

Public institutions confront a rapidly changing future. Because they play an important role in education and regulation, much of their current agenda includes concern about resource and environmental issues. For example, USDA has, in the past few years, been refocusing research programs toward low-input, sustainable agriculture. Clearly identified funding is starting to go into this area. Nationally, the Cooperative Extension Service is building a greater focus on contemporary issues into its educational agenda. New initiatives are now in place to redirect activities.

Each group in agriculture is a developer, a communicator, and a user of information. We have begun to expand the traditional model where data and recommendations are generated by the public or private research laboratory and then passed through extension or private marketing channels to the end user--in this case the individual farmer or rancher. A new concept is to develop participatory networks in which each person in agriculture is identified as both a generator and a user of information. We are struggling with how to collectively manage this new, open, multi-directional information environment. Extension special-

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Charles Francis is Professor of Agronomy, James King is Associate Professor of Agricultural Communications, James Bushnell is Assistant Director of Cooperative Extension, and Leo Lucas is Dean and Director of Cooperative Extension, University of Nebraska, Lincoln, NE 68583. Jerry DeWitt is Associate Director of Cooperative Extension, Iowa State University, Ames, IA 50011.

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ists have always met and discussed constraints and alternative practices with farmers. There is a need to further expand participatory and efficient strategies for information exchange, as illustrated in Figure 1 (King, et al., 1989).

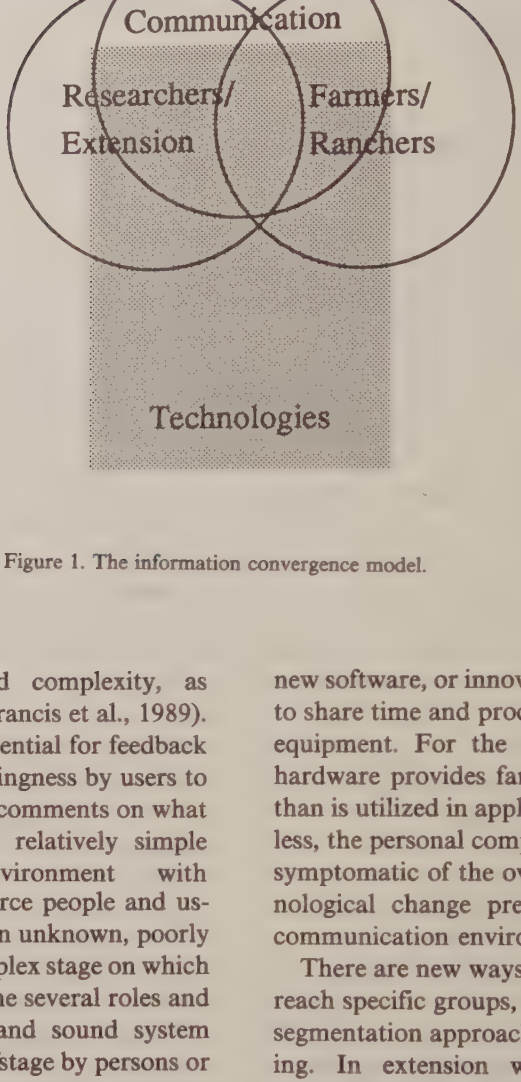

Figure 1. The information convergence model.

Significant current changes in perspective

In concert with these changes in agriculture, in agribusiness, in public institutions, and in our understanding of the environment and of complex biological systems, we are experiencing a technological revolution. This includes communications hardware and applications, biotechnology, and a global information and business network. What are some of the principal changes to which we will respond with participatory strategies?

Changing information environment

The primary changes in the information environment relate to volume of messages and complexity of what they contain. That we are drowning in information, yet starved for wisdom is a trite summary of our frustration with information overload. There is little time to absorb and process incoming messages. We not only have a greater multiplicity of information sources, but a greater number of diverse and segmented audiences. There are large, medium, and small farms; there are full-time and part-time producers. There are "hobby" farmers and "serious" farmers; there are local and non-local landowners. At the same time, there are many new communication channels--cable and satellite television, home video, electronic mail, remote databases, FAX technology--that were little used for agricultural communication a mere decade ago.

Receivers of messages may become increasingly bewildered by conflicting information in a market- and advertising-driven culture, and thus feel the need to become participants in the system rather than passive observers. There is a convergence of information that brings specialists in research and extension close to farmers and ranchers in a mutual quest to understand complexity, as shown in Figure 1 (Francis et al., 1989). There is a greater potential for feedback and an increased willingness by users to share their results or comments on what is received. From a relatively simple communication environment with clearly identified source people and users, we are entering an unknown, poorly understood, and complex stage on which the players can assume several roles and where the lighting and sound system may be controlled offstage by persons or organizations unknown. Complex, changing, and unpredictable government programs add to the instability of the external environment. Figure 2 illustrates some of this complexity (Francis et al., 1989). With tools and processes to handle this changing information environment, producers will be empowered to acquire, sort, and use the full range of contemporary information resources.

Technological revolution in communications

Technology is growing faster than our ability to afford and apply it in education. "The only sure thing in buying a computer is that the technology will be out of date by the time the machine is delivered." Fortunately, we can upgrade our equipment with add-on devices, buy new software, or innovate with network to share time and procedures with othe equipment. For the average user, th hardware provides far greater potentia than is utilized in application. Neverthe less, the personal computer revolution i symptomatic of the overwhelming tech nological change prevalent in today' communication environment.

There are new ways to identify and t reach specific groups, as in the audienc segmentation approach used in advertis ing. In extension we target certai groups of interested clients who choos to attend meetings, but there is a nee for multifaceted approaches to reach wider audience. Shared databases, inter active video, CD ROM, satellite trans mission and reception capabilities a have overwhelming potential for inter active applications in agriculture. Th potential to describe a farm physicall through satellite imagery and to targe crops or practices to certain places o that farm are yet to reach applicatior Fine-tuning recommendations for appli cation of production inputs as a resul of greater definition in describing soil could be a part of tomorrow's decisio matrix--a complex area that is only no being conceptualized. There is a need fo increased accuracy of information, a re sponsibility shared by researchers, farm ers, and agribusiness interests. Colle

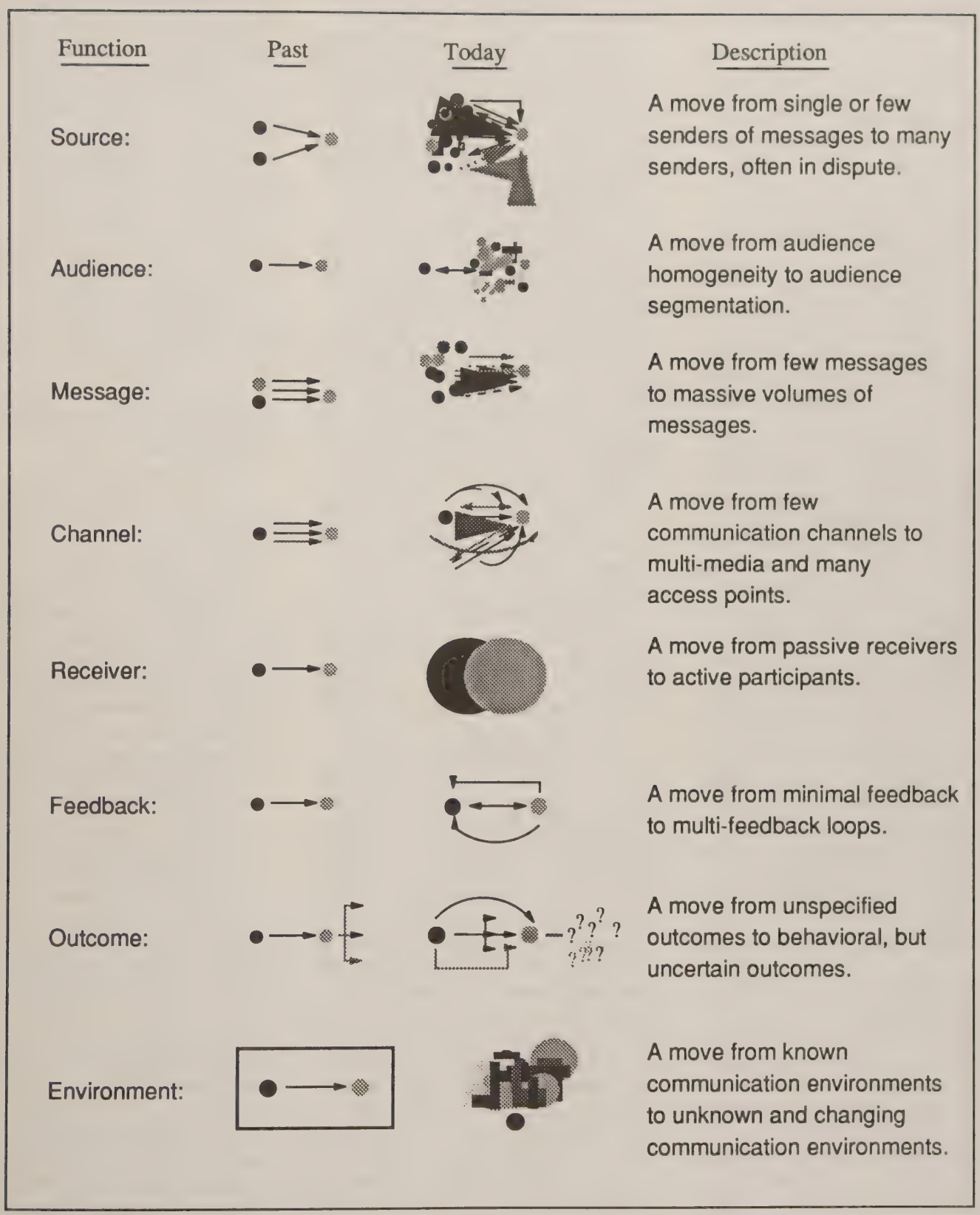
Function
Past
Today
Description
Source:
A move from single or few senders of messages to many senders, often in dispute.
Audience:
A move from audience homogeneity to audience segmentation.
Message:
A move from few messages to massive volumes of messages.
Channel:
A move from few communication channels to multi-media and many access points.
Receiver:
A move from passive receivers to active participants.
Feedback:
A move from minimal feedback to multi-feedback loops.
Outcome:
A move from unspecified outcomes to behavioral, but uncertain outcomes.
Environment:
A move from known communication environments to unknown and changing communication environments.

Figure 2. A description of the changing communication functions.

tion, processing, and interpretation of information is key to this process, as well as the means to communicate or share that information among those who need it. Increased producer participation is possible through their use of new technologies for rapidly accessing market reports, production recommendations, and weather data.

New understandings of interactions and connectedness

Another change in perspective is a growing scientific understanding of the cyclical relationships among components of cropping and crop/animal systems, as well as the biological connectedness of total systems. We have long understood details of the hydrologic cycle and how nitrogen and other elements are cycled through plants and animals to the soil. This knowledge is expanding in areas as narrow as soil microflora and fauna, and as broad as global systems that influence atmospheric carbon dioxide and the ozone layer. Now there is growing concern about the interconnectedness of systems and how disruption of one system in one part of the globe may have far-reaching and as yet unknown impacts on other systems vital to our survival. The developing theory of "chaos" adds to our ability to describe and understand these complex and dynamic systems. Within this context, we begin to examine food producing and other human activities in a new light. When possible we establish new yardsticks against which to measure the efficiency, appropriateness, and sustainability of specific practices or systems.

Longer time and expanded space frame of reference

Central to this rethinking of yardsticks is the growing concern about longer time and expanded geographic frames of reference for agriculture. To assure sustainability of food production, we must consider available resources to produce that food not just in the next year or the next five years. Long-term crop rotations and their effects on soils are more complex than specific nitrogen applications and responses in a single year. A measure of the economics of pumping irrigation water that takes into account the long-term availability of water, the costs of energy under potential price scenarios, and the impact of nitrate and pesticide leached into aquifers is far more complex than calculating a corn yield response to inches of applied water. In a global sense, "we all live downstream." The connections between humans and other species and specific farming practices are coming into clearer focus. The impact of water and nutrient cycles are interconnected across wide areas. Economically, we are turning into one global community based on trade, stability, and mutual interdependence. These are broader time and space frames than we traditionally consider when evaluating potentials and successes of specific components of agricultural technology. In a broad sense, the rules are constantly changing.

Evolutionary change in extension focus

Perspectives in extension also are changing. The change in name from "Cooperative Extension Service" to "Cooperative Extension" is one example of an evolving focus in this arena. From a traditional emphasis on service to farmers and ranchers, that is, providing specific recommendations on practices or facilities for activities, we are moving more completely into an educational mode. Today's environment has many information sources--federal and state agencies, private industry, and crop and livestock consultants, among others. Extension is assuming a greater role in providing the tools to empower agricultural producers to sort out these many recommendations and decide what is best for each specific farm and ranch. Extension is evolving, with increased emphasis on such areas as water quality, soil and water conservation, nutrition and health, and rural revitalization. This emerging role of extension as an educational organization is being aided by wide participation of diverse users at all levels.

In summary, these changes could be illustrated by a quote from a recent paragraph from the journal, *Technological Forecasting and Social Change* (Linstone, 1989):

"We cannot expect to succeed in th twenty-first century with nineteenth cen tury institutions. Structural change mus accompany major technological chang in any society; if it does not, the systen will exhibit increasing strains and th pace of technological change is likely t slow down. One beneficiary of system research may be the evolution of nev organizational structures in the publi and private sectors, ranging from th federal/state/local government to th corporation. A closely related questio is the desirable balance between powe concentration and distribution in th twenty-first century "information so ciety"."

Evolving focus in response to changes

Given the changes in information technology, and biological sciences what is the response of institutions an programs to address the new realities We are beginning to view each enterpris and each field in a new light, as they ar integrated into whole farm systems an into communities. There is a growin awareness of the limited non-renewabl resource base on which agriculture i built and how we must adapt future tech nologies and practices to that reality. Ex tension is looking both narrowly at th specificity of recommendations to farm and fields as well as broadly at the im pact of technologies and macr adjustments in agriculture on rural com munities. Here are some specific area in which we are adjusting direction an programs and which reflect the balanc and diversity that are likely to be foun in extension in the future (Francis et al 1988).

View of systems and farms as biological units

In a reductionist approach to th study of component technologies, the f cus has been on hybrids, fertilizer level herbicide rates, and economic return specific input levels. Accepting the vit and continuing importance of researc on these components, we need to con plement current activities with a broad

approach to measuring the biological and economic impacts of technologies on whole farm systems. In a sense, the farm becomes the biological unit on which success or failure is measured. Rather than bushels per acre or net profit per enterprise, the farmer could look at both net farm income per year and stability of that income over many years. Certainly the biological view is vital to survival of each farming or ranching unit.

Renewable resource use efficiency

As developed over the past several decades, agriculture has become increasingly dependent on fossil fuel based production inputs, especially chemical fertilizers and pesticides, and diesel for machinery, steel, rubber, and irrigation pumps. These technologies are sensitive to the supplies and prices of external non-renewable fuel resources. Reliance on high levels of these inputs has reduced the efficiency of use of renewable resources such as biologically fixed nitrogen, rainfall, and system benefits such as the rotation effects. In the future we will be increasing our relative use and reliance on renewable resources found on the farm (Francis and King, 1988). It will be important to focus research on greater efficiency in use of resources from whatever source. In addition, such complex issues will require greater emphasis on interdisciplinary teams.

Process approach to solving production constraints

We have developed a generation of researchers and producers who seek a formula or product in a package to solve most production problems. In the future it will be important to evaluate a series of alternative solutions to each production problem. We also need to build an understanding of the entire farming enterprise and environment and the process needed to remove or minimize limitations in the system, as opposed to spraying or applying a product as the only alternative (Francis et al., 1988). A process approach means using questions and involving audiences to solve problems. Research and extension teams are needed here as well, and these teams can include farmers and ranchers.

Specificity of results and recommendations

To extend the concept of a process approach to removing production constraints, we need to explore the specificity of results and recommendations and the most efficient ways to apply them to a specific farm. Most available information was developed under experimental conditions in a few locations (for example, response to nitrogen fertilizer) or was derived from many comparisons across a wide area (for example, comparisons of corn hybrids). In either case, the relevance of the results depends on how similar the testing sites are to the farm on which the information is to be applied and on the rainfall and other conditions of the coming season (Walters et al., 1990). Recommendations are based on probability of response to a given fertilizer rate, herbicide application, or tillage option. The challenge to each farmer is to maximize the probability of success of a given practice. One of the ways to supplement available data is to participate in the generation of that information--the on-farm trial.

Diversity of enterprises and products

There is value in both the biological and economic diversity that comes from additional enterprises or value-added products. Although many producers have reaped the benefits of specialization in one or two crops, many successful managers in the future will base their plans on flexibility and diversity in crops and products. Crop rotations and more complex sequences and patterns of plants can help control insects, weeds, and pathogens. In the Great Plains, windbreaks can reduce crop transpiration and increase yields. A more diverse array of crops allows the farmer to use new rotations and respond to changing market dynamics and export opportunities. Instead of concentrating on exporting a large volume of low-value feed grains, Midwest producers can convert a part of this crop into value-added products that use local raw materials and enhance the economic viability of the community.

Assuming risk of new technology

A common assumption about new technology has been that government, university, or industry should assume the risks of innovation. Recommendations to producers have promoted only practices that have been proven successful over several years on experiment station fields. In reality, producers have long assumed the risk of widespread application of new component technologies. Recognizing this, extension specialists can take two steps to help producers evaluate all available options and minimize risk. One is to get results from research out more quickly. Even though results may be preliminary or based on only two years or several locations, we can carefully explain how information was derived and how confident we are with the conclusions. Farmers can accept some risk of the new practice by adopting on a few acres and seeing if it fits their operation. The second is to provide better guidelines on how to do valid on-farm testing so that farmers can collect repeatable data and have confidence in their observations when trying new technology. These steps will help innovative farmers both to test new ideas and to minimize their risk in making changes in management. Many universities now move information quickly from any available source to farmer and rancher clients in their state.

Concern about community viability

For many generations agriculture has followed a trend toward larger units and fewer people on the farm, just as other industries have specialized and expanded. In agriculture, this has made it hard for those with limited resources who would like to begin farming and has made it more difficult for rural institutions to support the remaining population. We have been taught that "bigger is better," or "get big or get out!" Yet Wendell Berry asks the question, "Would you rather have the neighbor's

farm, or have a neighbor?" The trend could be reversed by a new focus on farms as biological units, on diversity, on management as a substitute for purchased inputs, and on more value-added activities on the farm and in the community. Viable farms and families can help support viable communities, a crucial factor in preserving the quality of rural life that will keep agriculture strong. It is important to develop technologies, systems, and agricultural policies that will encourage viable communities and infrastructure, and not just a short-term profit from continuous monocropping.

Participatory strategies in extension

In response to the changes outlined above, what are some of the specific participatory strategies and approaches being explored and tested in universities, federal and state agencies, nongovernment organizations, and industry?

Shared responsibilities in research and extension

In the past several years, there has been a resurgence of interest in demonstration plots and hands-on involvement of farmers in the research process. This interest has grown out of a long-term involvement by researchers working together with farmers in cooperative trials on farms. Practical Farmers of Iowa, for example, has established a network of producers who organize on-farm research plots, conduct field days, and present extension-type meetings around the state (Thompson, 1989). They have an on-farm research coordinator hired through Iowa State University to work with the network. The Nebraska Sustainable Agriculture Society and University of Nebraska have cooperative projects in which trials are designed cooperatively by producer/members and project technicians. Farmers provide ideas as well as inputs for the experiments, and technicians collect some data and help with harvest. Results are analyzed by the technicians, but interpretation is left to the farmers who thought up the trials. With the plots used as demonstrations and the results used in meetings the following winter, this is a collaborative operation in which farmers participate in both the research and extension aspects of the process. Other activities include the Nebraska Ecofarming Conference and Irrigation Short Course that have developed into viable annual events to which many farmers have been attracted and where they often participate in panel discussions.

Farmers as full participants

Each participant in the research/extension effort brings certain ideas and resources to share. In one Nebraska project, farmers articulate the prime questions that need to be answered by research on their farms, and similar questions are investigated on several farms in the region. Technicians provide a soil probe for taking deep soil samples. The soil analyses are paid from grant funds. Farmers apply the treatments--nitrogen levels, weed control options, cropping system alternatives--with a technician providing some design support. University people assist with some observations and data collection, frequently visiting the fields and talking with farmer participants. Yield data are collected by farmers, with help from the technicians if needed. Both participate in the final interpretation of the data. Farmers are full members of the research/extension team. This active participation approach is gaining favor in the areas where it has been applied.

On-farm to on-station experiment spectrum

There is an ongoing debate about what types of research and validation should take place on experiment stations in isolated projects and what types are most appropriate on farms with farmer participation. Recent evaluations of statistical analyses with large plots suggest that research in either location can be equally precise and that we have a range of choices in how to conduct credible research (Rzewnicki et al., 1988). Over several years, large plot research was conducted in Nebraska and Iowa both on farms and on experiment stations. I plots from 125 to 1200 feet long and to 40 feet wide, we used full-sized cor mercial equipment to carry out all oper tions. Yields were obtained by harvesti with a combine. We did analyses of va ance for a standard randomized cor plete block design. Coefficients of vari tion (CVs) were consistently less tha ten percent and often less than five pe cent, which shows that this type of lar plot can give precise results and allo valid comparisons among treatments.

Because of the high precision obtai able with large plots on farms, we su gest that trials or validation plots be l cated on whatever type of site can be meet the objectives. If the major obje tive is to compare large numbers of trea ments, or if many observations are be taken and control is needed over th conditions of the trial, then an exper ment station may be the most logical sit If there are relatively few treatments, if demonstration of practices or varieti to farmers in large plots is desired, the a replicated strip plot trial could ser both purposes. Even if a single plot p treatment is planted for demonstratio on each of several farms, the data ca be pooled using locations as replication Corn hybrids evaluated in large plots u der irrigation in Clay County, Nebrask gave CVs less than five percent in eac of four years in a recent experime (Rzewnicki et al., 1988). The Practic Farmers of Iowa routinely conduct fe tilizer, herbicide, tillage, and variety t als in large plots; CVs are regularly b low five percent. On-farm activities ca complement station trials. Farmers ca be full partners in the development new research-based information and re ommendations.

Model farms and master farmers

Farms that house trials or demonstr tions could be considered model farm at least for that specific practice. Th operators of these farms are among th most concerned in their communiti about ground water pollution, pesticid problems, and costs of production. Oft they are leaders in a sector of the cor munity, and they might be considere "master farmers" in that area. There

a successful model in many states in horticulture and vegetable crops where "master gardeners" participate in tours and meetings, write columns for the paper, or publish their ideas in other forms. Forestry projects in Iowa also follow this model. This same concept could be extended to our work with livestock and field crops. The demonstration farm is another exciting part of this idea. Using the model pioneered by Richard and Sharon Thompson and Practical Farmers of Iowa, it is possible to establish an extension network, including highly successful field days, even if this is done outside the normal extension meetings and tours. Both approaches are appropriate and compatible, but they reach different audiences. In this strategy, extension becomes a facilitator for moving information.

Decision case method of extension teaching

The decision case method of instruction, or structured learning, has long been used in law and business schools. This participatory approach involves creating a realistic scenario in which students have to absorb a situation, process the data, and reach a conclusion or decision right away. They have a chance to share their decision, and debate ensues among the students. The case model has promise in agriculture, especially in extension. A landmark project proposed by the University of Minnesota, and now being tested by the University of Nebraska, has brought this potential to the Great Plains. Background information leading up to key production decisions is presented during a group extension meeting. Each person is asked to make a decision on the inputs and cultural practices to be employed. People then discuss their choice. This can be done with an entire class or meeting or with smaller discussion groups. In either situation, each individual must process the data and must integrate this with personal experience to make the most logical, profitable, and sustainable decision about the production system. The case approach uses producer's existing knowledge by stimulating their entire cognitive system. Complex problem-solving strategies and self-directed experiences are employed to retrieve on-farm, local knowledge and then apply it in new and creative ways. The success of this approach in agriculture must await further testing, but it appears to have great merit for extension teaching.

Educational role of land grant universities

The traditional role of land grant universities has been agricultural education, with extension and research the two logical components that are added to formal classroom teaching. Research is stimulated by needs discovered in the classroom, by extension communications with farmers and ranchers and by funding opportunities. Extension is moving from a service role to a more intense educational mode. Participatory types of learning experience have been shown to be more effective than formal lectures. In meetings, we have found that farmer panels, discussion periods, and other interactive workshops are well received by producers and others in the audience. Farmer panels have been used successfully in Nebraska for many years. This is sequential learning that builds upon what is known and observed during the process. New technology will encourage even more interaction; two-way satellite communications, for example, can allow questions and answers as well as active discussion across many miles. In-home interactive systems are farther down the road, but the technology is already here to make them happen if there is interest and investment in needed hardware. AG*SAT, the national land grant satellite-based educational distribution system now coming into existence, will be an important and pioneering instructional and technological effort to extend the universities' impact and reach.

Other significant players in education

Traditionally, the universities were the main players on the educational field, with access to students who could not get needed background and skills in any other way. The rise of state college systems, community colleges, and specialized trade schools has changed this environment. There is a high level of education/training conducted today in the private sector, and by some reports their budget is larger than the entire annual public education investment. Industry is well aware that the general preparation people receive in the public sector is not sufficient for skillful job performance, and companies have taken on this task at their own cost. In other situations, the preparation needed in today's technology-related businesses requires specialized training otherwise not available. Therefore, the educational field is a complex one, with many more players than we had in the past. Public educational institutions are adjusting to fit specific niches and to do those things they do best; they are providing a good general background and general education for tomorrow's leaders and citizens. In Nebraska, the university and extension system is joining forces with the community colleges, state colleges, and technical schools to form an educational "shopping mall." This broad-based, emerging educational center will offer a wide variety of instructional services to many communities in the state. This strategy is a participatory approach to education.

Education leads to empowerment

In the case of agriculture and farming/ranching practices, producers need to know the basic elements of production systems and need to understand how the pieces fit together and interact. With this basic understanding, it is possible to analyze carefully the individual components of an operation and rationally evaluate potential changes. We have moved to an era where recommendations usually are specific, and we often extrapolate too far from the place where an experiment was run to the sites where that recommendation should be applied. Any recommendation about fertilizers, hybrids, or herbicides to be used really constitutes a statement about the probability of success, based on research and prior experience. We need to find a method to improve the probability that each producer's decision will be the best one

for that farm or ranch. The way to do that is through education that gives people the tools to evaluate technological alternatives objectively. In the future, extension will be more focused on providing methods by which farmers can test their own technological alternatives, such as through use of long strip tests, so that they can formulate their own recommendations instead of seeking a single opinion and then investing scarce resources to follow that one alternative. Farmers share in gathering and evaluating information; they also share in the risk of applying these practices. This is empowerment through education.

Conclusions: Toward a new paradigm in extension

New strategies and activities are being tested and in some cases vigorously pursued in extension. Some of the ideas and approaches reflect programs that have been successful in the past, while others build on experience and use today's improved communications technology. The changes in hardware and software that have been developed in the last decade have been slowly adapted for use in agriculture. We need to accelerate the most appropriate of those applications.

The participatory approach has great appeal to producers and is educationally sound. Participants remember and use information that is processed and experienced. The decision case approach in meetings and the classroom, the on-farm experiment or validation trial, and the tours and active participation of producers as full members of the research/extension team all are valuable in this new information environment. Participatory strategies are consistent with the new national and state extension priorities. This direction will help us promote success in agriculture into the twenty-first century.

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Farm profiles invited

For its new department on alternative agriculture profiles, the AJAA welcomes short articles describing farmers who have adopted interesting alternative practices. The articles should include five elements: a brief description of the farm; the problems that made the farmer look for an alternative approach and the reasons why the alternative seemed plausible; a summary of the basic principles behind the alternative (possibly in a sidebar if it interrupts the flow of text); a discussion of how well the alternative has worked; and a discussion of the applicability of the alternative for other farms. The length should be 1500 to 2000 words.

Submissions must be accompanied by a release, signed by the farmer, giving permission for this material to be published in the *American Journal of Alternative Agriculture*. Vol. 3, No. 4, of the AJAA has a further description of the department (page 188); or query the editor for further information. Send submissions to the Editor, AJAA, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

Broad-based coalition offers alternative for USDA research budget

A broad-based coalition of agriculture, environmental, and consumer groups, including the IAA, has developed a proposal to increase and reallocate the Bush Administration's proposed budget for agriculture research and education. This alternative proposal redirects the USDA's funding request to focus on sustainable agriculture, including more interdisciplinary and farming systems research, technology assessment research, extension agent training, composting research, minority farmer outreach, organic farming standards, and more funding for Low-Input Sustainable Agriculture (LISA) research.

Despite the 1990 Farm Bill's mandate for USDA's research to emphasize alternative agriculture, the proposed USDA budget contains insufficient funding for sustainable agriculture research and education. The 16-member coalition proposes increasing USDA's $33.9 million research budget to $138.85 million; it recommends an increase in LISA funding from $4.5 million to $30 million. The increase would be achieved by redirecting some of the $1.6 billion total Executive Request for agriculture research and education funding.

Participatory research: A farmer's perspective

Gordon Watkins

Abstract. *U.S. land grant institutions currently follow a "top-down" model of research and extension in which farmers are the passive recipients of research results based on perceived needs which have been identified, prioritized, and investigated by scientists with little input from the end users. This exclusionary approach was designed to meet the needs of large scale, mono-cultural farming systems. However small scale, diversified, integrated systems are better served by a more participatory approach to research and extension in which farmers are actively involved as peers of researchers and extensionists in identifying research needs, designing and implementing experimental protocols, and delivering research results. This paper provides a brief outline of an alternative to the top-down approach termed "Farmers-First-and-Last", developed and tested by Robert Chambers of the Institute of Developmental Studies, which has been effective in working with diversified farmers in developing countries.*

Key words: participatory research, peer level participation, client orientation, farmers-first-and-last, Robert Chambers

I am excited to be a part of this symposium today, which is exploring new ways to make our agricultural research and educational systems more responsive by creating partnerships among farmers, researchers, and extensionists.

As an organic farmer, and having helped organize a Farmer-to-Farmer Technical Assistance Project with an on-farm research component, I am frequently frustrated by the lack of interest from our land grant institutions and by our lack of power to influence their research agenda in the area of sustainable agriculture. Too often the research which is done is insufficient or inappropriate for our needs, but, lacking the time and financial resources to undertake our own scientifically designed, randomized, replicated research projects, many farmers are forced to plod along with trial and error research, which most scientists would take me to task for even calling research. This "homegrown" research slowly yields results which, while useful to the participating farmers, does not often stand up to scientific scrutiny and therefore sees limited adoption on a wide scale. What is most frustrating about this predicament is that research done under more carefully controlled conditions, particularly in the areas of soil fertility, weed management, and pest control, would quickly yield results which would make the sustainable agriculture movement more competitive in the marketplace and counter the arguments of detractors who claim that high production costs make sustainable agriculture economically unfeasible. On my own farm, for example, I am confident that, if our universities would divert some of the attention they now give to herbicide research to the development of efficient machinery, I could drastically and quickly reduce the high costs I now incur for manual weed control in my blueberries and other crops.

Adequately addressing this problem, however, requires more than simply shifting the focus of research in this country. It requires a shift in funding mechanisms away from the private sector with its special interest in producing profitable products towards public sector funding which is working in the interest of the whole farm economy. While I applaud the USDA for carrying out the LISA program, it receives only miniscule funding and is constantly fighting for its life. But, more important than funding, a shift in the very structure of agricultural research and extension is required, a shift away from the current hierarchical, top-down approach, often criticized by farmers as being elitist and exclusionary, towards a more egalitarian, participatory approach in which farmers, researchers, and extensionists alike function as peers.

The creation of such a partnership, which is what we are exploring here today, has, from a farmer's perspective, several foundation principles which must form the basis of any new model if a meaningful partnership is to be built. I have borrowed freely here from the work of Robert Chambers (1985, 1986, 1988a, 1988b) of the Institute of Developmental Studies, Sussex, England, who works extensively with farmers in developing countries and who has developed what he calls the "Farmers-First-and-Last" approach to participatory research. These basic principles are as follows:

Farmers as a legitimate source of information. Our educational system teaches us that learning is a hierarchical process. We "learn from above and teach to below." This instills a sense of intellectual superiority among scientists and the assumption that only they can and should determine research needs and design. This elitism must be overcome and farmers must be recognized as legitimate sources of knowledge and information if we are to draw from farmers' vast pool of practical experience.

Farmers as the point of reference. In our current system, the research community itself is most frequently the point of reference by which success or failure is measured. Chambers (1988b) states that, "farm families are from start to finish the primary actors and points of reference, with their priorities coming first, and with outsiders supporting farm fam-

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Gordon Watkins is an organic farmer, Rivendell Gardens, Route 1, Parthenon, AR 72666.

ilies in their innovations, experiments and trials."

Farmers as peer level participants. Research in the top-down model is identified, designed, implemented, and delivered by scientists and extensionists and farmers are involved only as passive recipients of the final product. Often the unfortunate result of this approach is research which is insufficient, inappropriate, or impractical for the farmer. Farmers must be actively involved as equals in the entire research process rather than as subordinates or passive recipients of research results.

Outsiders as conveners, catalysts, colleagues, and consultants. Researchers and extensionists should assist farm families in analyzing and identifying research needs, supplying ideas and technologies, and assisting in experiments rather than acting as "missionaries," spreading the good word passed down from on high, or "doctors," attempting to cure the ills of agriculture.

Client orientation rather than output orientation. The measure of success in our current system is often the level of output in terms of published articles or, in a stricter sense, bushels per acre, rather than a more service-oriented measure of responsiveness to user needs.

Chambers' model is only one of many, and I have done it an injustice by providing such a brief sketch of what is a complex, well thought out, and field-tested approach to participatory research. While it may seem somewhat radical to some, as a farmer I feel that these basic principles are the cornerstones of any new model for creating meaningful partnerships; and I hope this presentation can at least serve as a jumping-off point for our discussions and explorations today.

Unfortunately, there are some who would suggest that farmers are too narrowly focused on their own specific needs to adequately address research areas of wider impact. This is where the consulting and convening roles of research and extension become important. Researchers and extensionists must assist farmers in identifying approaches to research which will benefit the farm community as a whole while also meeting the participating farmers' specific needs. The two need not be mutually exclusive. It is unfortunate that participatory research is perceived by some as a threat when, in reality, it will have an empowering effect on all involved and will result in a more efficient and effective system.

I invite all of you here to give serious thought to ways in which we can evolve a new, more responsive approach to research in which we can truly learn from each other and take advantage of the tremendous resources offered by farmers, researchers, extensionists, and others involved in agriculture today, a partnership which will surely benefit us all.

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UPCOMING EVENTS

June 3-5. Environmental Leadership Conference will be held in Washington, DC, to identify national priorities. Contact Renew America, 1400 - 16th Street, NW, #710, Washington, DC 20036; (202) 232-2252.

June 6-7. "Diet and Health: Where is America Going?", a conference sponsored by the Center for Science in the Public Interest, will be held in Washington, DC. Contact the Center, Diet and Health Conference, 1875 Connecticut Avenue, NW, #300, Washington, DC 20009.

November 21-22. Conference on Innovative Policies for Agricultural Research seeks papers on professional and institutional reforms to allow research to foster a more resource-conserving and publicly responsive agriculture. Abstracts due by **July 15**. Contact William Lockeretz, School of Nutrition, Tufts University, Medford, MA 02155; (617) 391-1033.

August. "Sustainable Development for the Third World," a course linked with another in Mexico, will be held in Cottage Grove, Oregon. Contact Aprovecho Institute, 80574 Hazelton Road, Cottage Grove, OR 97424; (503) 942-9434.

September 16-22. Organically Grown Week is sponsored by the Committee for Sustainable Agriculture. Contact OGW91, P.O. Box 1300, Colfax, CA 95713; (916) 346-6366.

August 11-16. Eighth Annual Institute on Livestock in Development will be held at the New Windsor Service Center, Maryland. Contact Dan Gudahl, Training and Admin. Assoc. Heifer Project International, P.O. Box 808, 1015 S Louisiana, Little Rock, AR 72202; (501) 376-6836.

September 25-27. "Children, Youth and Their Families," the 11th Annual National Rural Families Conference will be held at Kansas State University. Contact the Conference Office, Kansas State University, 241 College Court Building, Manhattan, KS 66506-6009 (913) 532-5575.

The on-farm research program of Practical Farmers of Iowa

Richard and Sharon Thompson

Abstract. *Practical Farmers of Iowa is a grassroots organization whose members conduct research on profitable, environmentally sound alternative production methods on their own farms. The experimental design uses randomized, replicated side-by-side machine-harvested strips running the length of the field. Production techniques investigated include ridge tillage with and without herbicides, ridge tillage and conventional tillage without herbicides, with cover crops, and with late spring soil nitrate tests to determine efficient N application rates. This work has led to effective cooperation among farmers, extension personnel, and university researchers, and has inspired similar activities in other states.*

Key words: on-farm research, ridge tillage, nitrogen fertilizer, information transfer, experimental design

The organization

Practical Farmers of Iowa is a grassroots farmer organization that guides research on environmentally sound and profitable farming practices and encourages their adoption. It was founded in 1985 by a steering committee of five people. With early encouragement from the Rodale Institute and initial financial help from the Wallace Genetic Foundation, it has become a statewide organization. The five-person steering committee has turned into a membership of 350 and an elected board of directors, with 28 farmer cooperators doing research. PFI now is funded with petroleum overcharge money through the Iowa Agricultural Energy Management Council of the Iowa Department of Agriculture and Land Stewardship. It neither sells agricultural products nor endorses them and has no commercial sponsors or advertisers.

Research program

The heart of PFI's program has been on-farm research plots. Since 1987, over 160 field trials have been conducted by PFI farmer-researchers. The PFI farmer-researchers decide what experiments to conduct on their own farms and collect the data themselves. Although the field trial design is a simple one, it allows trial results to be evaluated statistically on each farm. Typically, these trials compare the farmer's customary practice side-by-side with a single alternative practice. Some examples of previous and current projects include the following: nitrogen management using the late spring soil nitrate test; comparisons of weed control with and without herbicides in a ridge till system; comparisons of ridge till and conventional tillage, with no herbicides used in either system; and using fall cover crops for soil improvement and erosion control.

Practical Farmers of Iowa is involved in numerous research projects and demonstrations in cooperation with universities and industry. In addition, a joint project involving PFI and Iowa State University, funded in part by the Northwest Area Foundation, is examining social, economic, and biological aspects of sustainable agriculture in Iowa. This project is a part of the Foundation's multi-state analysis of the impacts of sustainable agriculture.

On-farm design

The greatest challenge was to convert demonstration strips into plots from which data could be collected that would tell us the truth and satisfy professional researchers. Farmers in the past have placed check strips across their fields to determine yield differences between two treatments. The check strips were repeated several times. University researchers indicated that the data was not valid and that the yield differences could not be analyzed statistically because the plots were not randomized.

Can farmers have randomized replicated trials that can be machine harvested with the data subjected to statistical analysis? Experience at the Thompson farm has shown that a randomized complete block design does not work with large plots because the variability is too great for proper randomization. For example, hairy vetch interseeded under corn for only four months appeared to have significantly increased corn yields in the current year by 13.27 bu/acre at the 95 percent confidence level when compared to no-cover and rye treatments. However, the differences probably were caused by variation in soil type and drainage, not by treatment. Randomization could not distribute the treatments evenly because of the size of the plots (12 plots, each 48 by 575 feet, covering a total of eight acres). In

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Richard and Sharon Thompson farm near Boone, IA 50036.

contrast, when hairy vetch was compared side-by-side with no cover crop, the corn yield advantage with hairy vetch was insignificant at 3.9 bu/acre. The side-by-side comparisons used the entire length of the field and did a better job of dealing with the variations in the soil types.

Small "garden plots" common in experiment station studies also have very little variability and work well but do not lend themselves to on-farm planting and harvesting machinery. However, we do not have to choose between randomized replicated university tests and unreplicated side-by-side on-farm comparisons. We can have the best of both worlds. It is called randomized replicated side-by-side comparisons. Now we have the tools to document new ideas at the farm level.

Figure 1 shows narrow strips going the entire length of the field, placed side-by-side to reduce the effect of field variation. Farmers can plant, cultivate, and harvest these strips with regular farm equipment so that this situation is more like the real world of farming. In this design each treatment is randomly assigned to one strip within each blo of adjacent strips. The reason for ra domization of treatments is that fiel usually are not perfectly level. Therefo if treatment B is always on the high side in relation to treatment A, it w have a yield advantage in a wet year ar a disadvantage in a dry year.

Six or more replicates are needed this design. The smallest yield differenc that can be stated with 95 percent conf dence equals the standard deviation of bu/acre times the t value for the appro priate degrees of freedom (number

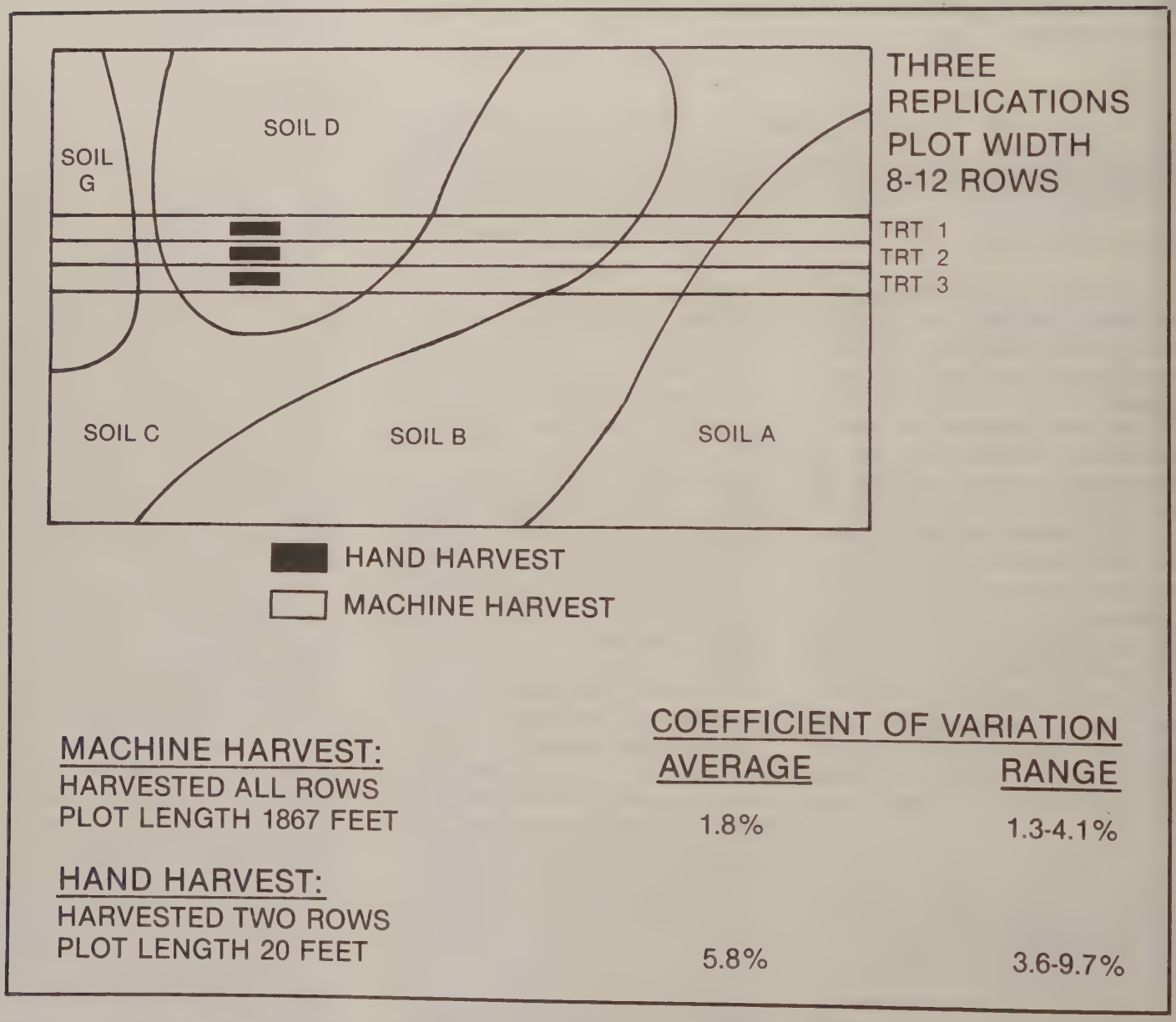

Figure 1. Conceptual drawing of strip test plot layout showing soil types and hand and machine harvest plot areas.

pairs less 1). With only 2 pairs, the t value is 12.7 so that the least significant difference (LSD) would be 38 bu/acre. With 6 pairs, t is 2.57, resulting in an LSD of 8 bu/acre. If the number of pairs is increased beyond 6, LSD decreases only slightly.

Research by Shapiro et al. (1989) at the University of Nebraska shows that long narrow strip tests, when replicated, increase statistical precision as a result of representing the population of inference better. Machine harvest of corn was shown to have reduced variability (average coefficient of variation of 1.81 percent) when compared to hand harvest on the same plots (average CV of 5.82 percent). This finding should encourage cooperation among researchers, extension workers, and farmers.

The level of experimental error in all the trials was well within the limits normally accepted by researchers in agronomy. Plots ranging in length from 125 to 1200 feet and as wide as one or two passes of standard farm machinery gave experimental results that were statistically sound, meeting statistical requirements for randomization and replication. Comparison strips in Iowa that were 1200 feet in length and replicated four to eight times had a range of CV from 0.7 to 5.9 percent. These low coefficients of variation for such large plots can best be explained by noting that the long, parallel side-by-side plots go across a range in field variability, with all plots in a given replication exposed to about the same range (Figure 1). These results have caused the authors to rethink the potential for on-farm, large-scale plots (Rzewnicki et al., 1988).

Franzluebbers et al. (1988), comparing experiments designed and conducted by farmers to those planned and controlled by researchers on farmers' fields, report the latter may cost three to five times as much per trial; experiments on the research station may cost over ten times what a similar trial would cost when conducted by a farmer (Table 1). Although most precise research has been concentrated in the controlled conditions of an experiment station, recent analyses indicate that farmer-run trials can be both efficient and cost effective. The use of the randomized-replicated experiments on PFI farms has brought together professional researchers and farmers dealing with sustainable agriculture.

Nitrogen trials

PFI results from 1987 through 1989 showed no change in corn yields when purchased nitrogen application rates were reduced from an average of 129 to 75 pounds per acre (Table 2). The reduced range of 0 to 130 pounds, was lowered from the customary range of 60 to 190 pounds per acre. The data was consistent over the three-year period, with 31 out of the 35 trials showing no significant yield differences between the customary applied nitrogen rates and the reduced rates. The experiments were conducted in 22 different locations in Iowa. Yields ranged from a low of 20

Table 1. Costs and experimental variability of different research designs.

Research Design	Cost per Trial ($)[1]	Coefficient of Variation (%)[2]
On station, small plots; hand plant and harvest	11,263 (5,700 to 16,000)	8 to 15
On-farm, by researcher; 4 replicates, 40′ × 125′	2,950 (1,900 to 3,900)	4.5 to 15.2
On-farm, by farmer; 2 treatments; 6 to 8 replicates, 20′ × 1200′, harvest entire plot	800 (500 to 900)	0.7 to 5.9

[1] Franzluebbers *et al.* (1988)
[2] Rzewnicki *et al.* (1988)

Table 2. Average corn yields with different N fertilizer rates, Practical Farmers of Iowa, 1987-1989.

Treatment	N (lb/acre)	Yield (bu/acre)[1]
Customary N rate	129 (60 to 190)	121.7
Reduced N rate	75 (0 to 130)	120.3

[1] Average of 35 individual trials at 22 different locations. No statistically significant yield differences in 31 of 35 trials.

Table 3. Velvetleaf counts per acre with ridge till, with and without Dual herbicide, Thompson Farm.

	With Dual		Without Dual		
Crop and year	Plot #	Velvetleaf	Plot #	Velvetleaf	Diff.
1985 Corn	3	4	2	2	2
	6	332	5	101	231
	9	521	8	222	299
	12	645	11	583	62
1986 Soybean	3	22	2	15	7
	6	110	5	53	57
	9	570	8	253	317
	12	1091	11	598	493
1987 Corn	3	101	2	33	68
	6	202	5	156	46
	9	627	8	420	207
	12	2979	11	726	2253
1988 Soybean	3	52	2	122	−70
	6	402	5	420	−18
	9	1154	8	787	367
	12	2029	11	1312	717
1989 Corn	3	0	2	0	0
	6	15	5	13	2
	9	68	8	26	42
	12	48	11	13	35

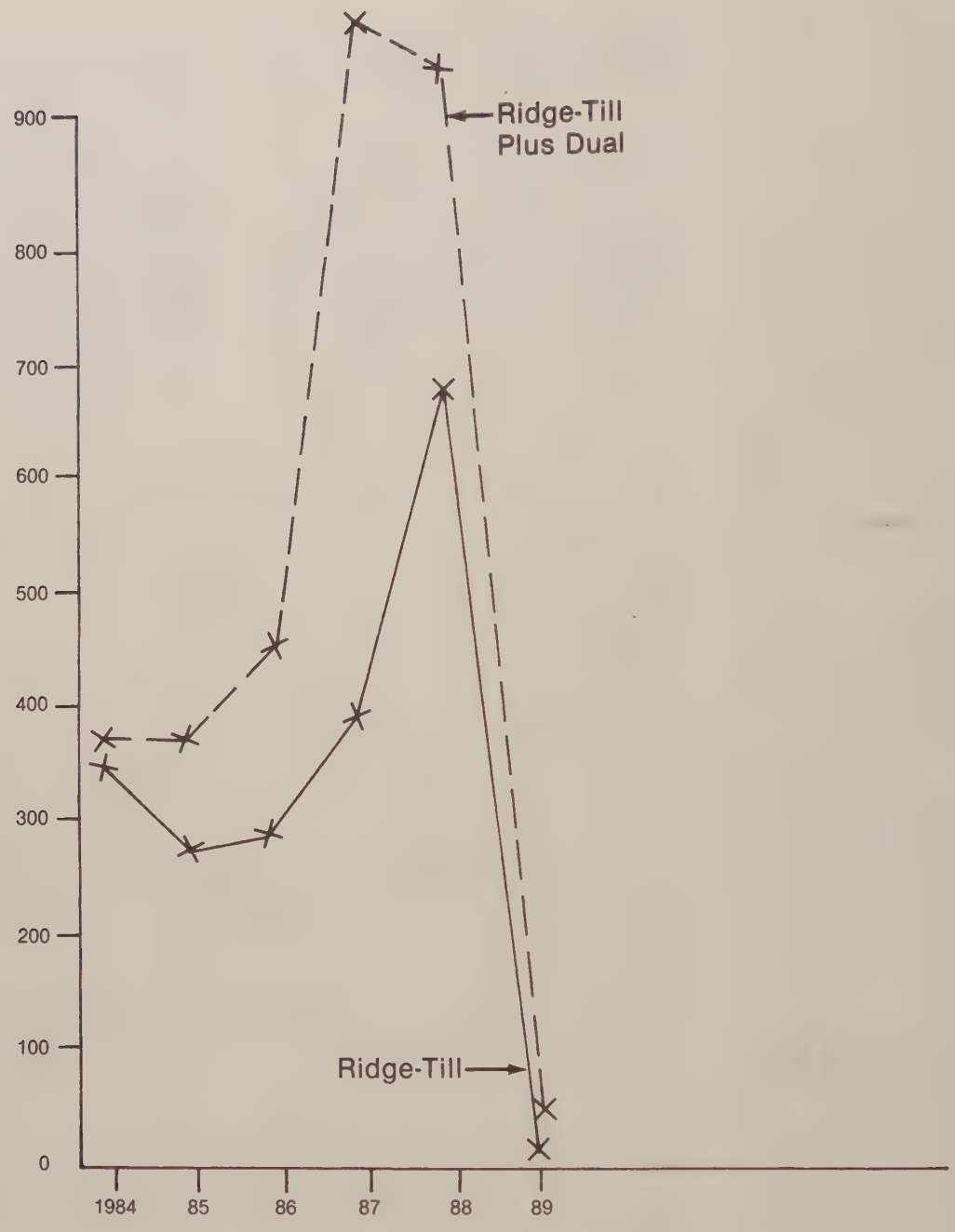

Figure 2. Average velvetleaf counts per acre in ridge tilled corn and soybeans, with and without Dual herbicide. See Table 3 for details on individual plots.

bu/acre during the drought year of 1988 to a high of 200 bu/acre in 1989 when rainfall was adequate. The late spring nitrate test was used to help determine the reduced rate of nitrogen application. PFI cooperators were the first farmers to use the Blackmer test kit to process their own on-farm soil samples.

The average difference between the customary and reduced application rate is 55 lb/acre. If the reduced rate were used on all corn in Iowa, it would mean savings of 110 million gallons of diesel fuel equivalent to $82 million dollars each year. The money saved would likely be spent in the local community. Also, the reduced use of nitrogen would decrease the amount of nitrogen found in the drinking water supply.

In 1989, 16 fertilizer dealers acros Iowa began using the late spring nitrat test. Nitrogen application rates were r duced from an average of 123 to 4 pounds per acre, and the corn yiel stayed the same at 130 and 131 bu/acr respectively. This is a "win-win" situ tion for the environment and for farmer

profits.

Ridge till reduces weed pressure

The 1984 through 1989 experiments on the Thompson farm comparing ridge till with and without herbicide have shown no differences in corn or soybean yields. The strips using the grass herbicide Dual had higher velvetleaf (*Abutilon theophrasti*) counts in 17 of 20 side-by-side pairs when compared with no herbicide (Table 3). All plots were rotary hoed and cultivated in the same way. Figure 2 shows the average for each treatment in each of the six years. The herbicide does not let the grass express itself and allows greater expression of other weeds.

Will this practice work on other farms? Three years of data from 1987 through 1989 at 12 different PFI cooperator locations throughout Iowa says that it will. Twenty-five out of 28 trials showed no yield differences in corn or soybean yields when herbicides were eliminated from the ridge till system (Table 4). Two trials showed significant increases in yields without herbicides, while only one trial had a yield decrease.

Farmers should not move directly from conventional tillage with broadcast herbicide to ridge till without herbicide. During the change period, herbicides may be reduced gradually. First, broadcast herbicides would be replaced by row application with the planter, then the row band rates would be reduced. Later, pre- and post-rotary hoeing would replace the pre-emergence herbicide.

Crop yields did not change when herbicides were dropped from the ridge till system. The question now being asked is whether there is a change in the weed pressure. The Leopold Center for Sustainable Agriculture at Iowa State University is funding a project by Dr. Tom Jurik, of the ISU Botany Department, to study weeds with and without herbicide in a ridge till system. These studies are being conducted on four PFI cooperator farms in north central Iowa. Dr. Jurik's conclusions for 1989 (personal communication) were that herbicides banded in the row at planting reduced the final number of broadleaf weeds slightly, but weed densities in plots without herbicide were also low. The results indicate that the ridge till system without herbicide does an excellent job of controlling weeds and has no adverse effects on yield. The effectiveness of rotary hoeing in the ridge till system in reducing weed numbers is emphasized by the results for the Thompson trial; plots with four rotary hoeings had weed densities similar to those on the other farms, whereas plots without rotary hoeing had ten times as many weeds. These results suggest that mechanical tillage such as ridge till can be an effective alternate to herbicides in a sustainable farming system.

Table 4. Average ridge-tilled corn and soybean yields, with and without herbicides, 1987-1989.

	With herbicide	Without herbicide
	bu/acre	
Corn (n=10)	118.3	118.0
Soybean (n=18)	40.9	40.7

Information transfer

Summer field days are held at most of the cooperating farms, with the farmer, extension workers, and researchers explaining the experiments. During 1990, 1200 people attended the PFI summer field days. Winter workshops are held in each of the five districts in Iowa, with farmers, extension workers, and researchers sharing their results for that year. PFI has worked to improve the dialogue between farmers and researchers. Several researchers are finding that PFI cooperator farms are unique field laboratories for studies of weed control and plant nutrition. Professional researchers were involved with seven different projects on the farms of cooperators in 1989.

In 1988, a coordinator, Rick Exner, was hired to facilitate these experiments and demonstrations. He holds the position of Extension Associate at Iowa State University; this may be the first time a grassroots sustainable farmer group has had a contractual agreement with a land grant institution. This arrangement between PFI and extension is intended to help extension present sustainable agriculture alternatives to every farmer in the state. A series of extension bulletins and programs is planned, targeted to farmers, 4-H Clubs, and Future Farmers of America classes interested in alternative farming methods.

PFI farmer-researchers have also traveled to other states, making more than 100 presentations a year about the design and results of their experiments. Other states are beginning to adapt the on-farm research design with farmer-researchers and the Extension Service field trials coordinator. Thus, Practical Farmers of Iowa has offered a model of constructive relationships among farmers, the Extension Service, and the University.

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LETTERS TO THE EDITOR INVITED

The AJAA welcomes letters, short or long, commenting on articles in this journal or sharing ideas likely to be of interest to other AJAA readers. Since our space is limited, we do reserve the right not to publish all letters or, at times, to publish only excerpts from them. To take part in this exchange of ideas, write to: Editor, AJAA, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

Agricultural addiction

Jim Bender

Abstract. *Impediments to agricultural change extend beyond lack of appropriate research and the federal farm program to addiction to use of agricultural chemicals. Several recent trends in American agriculture have been caused by or have resulted in dependence on agricultural chemicals. They include the continuing separation of livestock from farms, farm size, separation of ownership and farming of the land, discontinuity of learned procedures, part-time farming, and certain aspects of noxious perennial weeds. This implies that prospects for agricultural change are related to the trends with which they are associated.*

Key words: agricultural chemicals, chemical addiction, livestock, farm size, farm ownership, part-time farming, noxious weeds, information exchange

In the recent critically acclaimed movie *Drugstore Cowboy*, the central character, a drug addict, finally commits himself to a rehabilitation program. When he is signing himself in, he turns down the admittance counselor's encouragement to become a counselor himself, explaining that nobody has ever talked an addict out of a habit.

The line could have applied to agriculture: the concept of addiction helps in understanding the immediate future of American agriculture. The point is not to challenge the idea behind this conference. Of course, information generation and exchange is very important.

The importance of information can be overstated, however, to the detriment of full understanding of the problem. Consider the back cover of the National Research Council's (1989) study of alternative agriculture, which asserts that alternative methods have not been adopted because of lack of research and federal farm programs. Either some hyperbole was intended, or the problem has been seriously oversimplified. The idea of addiction becomes useful here.

Part but not all of the concept of addiction is the idea of dependence. Several major trends in American agriculture have been caused by, or have resulted in, dependence on agricultural chemicals. I will discuss six of them.

The continuing separation of livestock from farms

Many of us have insisted that a moderate-size livestock component generally is essential in alternative systems. Yet the trend in farm structure conflicts with this need. For example, with beef cattle, not only small feeding enterprises but also cow-calf operations are disappearing from farms. In just five years, from 1975 to 1980, there was a net loss of almost 10 percent of beef cow-calf operations from farms. Among the small operations, with 20 to 99 cows, the loss was 14 percent (Nelson and Van Arsdall, 1983). But that is only part of the problem. Costly investments in livestock production, such as fences, watering systems, barns, and handling facilities, are being destroyed.

Farm size

Farms get larger and farmers become fewer. Maybe a farm of any size can b organic. It is clear, however, that mar agement challenges become com pounded as organic farms become large Much can be done with competent, dedi cated help, but the two qualifiers- competence and dedication--are crucia

Separation of ownership an the farming of land

Over half the farmland in this countr is farmed by persons who do not own (Lewis, 1980). Farm tenants who wis to convert to stewardship agricultu face two problems. The first is that th methods and goals they adopt have on a long-term payoff. Second, they repla many cash inputs, whose costs usual are shared with the owners, by manag ment, which they largely bear then selves. Landowners who do not respon appropriately put conversion-minde tenants in an unacceptable situation.

Discontinuity of learned procedures

Many young farmers are now two ge erations away from organic-related pr cedures. Generally their parents al have known only chemical agricultur Although once again I am talking abo information, there is an important diffe

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Jim Bender is an organic farmer near Weeping Water NE.

ence. The information imparted when moms or dads show their sons or daughters how to do something on the farm is special. Its absence can be a profound loss, not easily duplicated by extension, the university, or anyone else.

Part-time farming

The combination of farming and a job off the farm is becoming increasingly popular. I know from personal experience that an organic farmer can work away from the farm, but it is easy to understand why chemicals are thought to be vital to combining these two roles.

Insidiousness of certain noxious weeds

Certain perennial noxious weeds have a very peculiar characteristic. They can be suppressed by herbicides but also continue to spread throughout a field. This means that a conventional farmer can control these weeds enough to harvest a crop while the basic problem actually gets worse. An example is field bindweed (Martin et al., 1976; Rosenthal, 1983; Peters, 1991). The reason is its ability to spread asexually, by roots and general tillage. Herbicides will mask these weed problems. Once herbicide use stops, however, the problems can be overwhelming, as in the classic pathology of dependence (American Psychiatric Association, 1987).

Each of these six trends has been partially caused by, or has resulted in, dependence on agricultural chemicals. Imagine the situation for the many farmers on whom all six converge. Perhaps chemical companies already understand this dependence. Marty Strange (1988) seeks to explain the odd nature of macho television ads for pesticides. He asserts that the subliminal message is: "You aren't good enough to make it without our products, and you know it."

I am not seeking either to criticize or to elicit sympathy for farmers. My purpose is simply to gain perspective on the role of information in the near future of American agriculture.

Information remains vital, however. After all, to turn again to the movie, the addict did hit bottom and then decided to get help. It was crucial that the rehab center was there for him. But, as he seems to have conveyed to the counselor, decisions come hard and are somewhat impervious to information when one is addicted.

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Continued from page 146

program, the seventh in the Institute's annual series, included farmers, extensionists, policy analysts, and researchers and research administrators. The papers that appear here, initially presented at the symposium and later, following peer review, revised by their authors, provide a cross section of views and insights regarding the character, needs, and promise of sustainable agriculture research and information programs.

We wish to thank the authors for their enthusiastic participation in the symposium and for their diligence in preparing and revising their manuscripts. We also wish to acknowledge and thank Charles Hess, Assistant Secretary, Science and Education, USDA; Myron Johnsrud, Administrator, Extension Service, USDA; and Ward Sinclair, an organic farmer near Warfordsburg, Pennsylvania, for their oral presentations which added significantly to the breadth and perspective of this highly successful event.

Finally, we thank the symposium moderators: William Liebhardt, University of California-Davis; Michael Heller, Director/Farm Manager, Clagett Farm, Chesapeake Bay Foundation; and Jerry DeWitt, Associate Director, Cooperative Extension, Iowa State University.

Programs such as this require a great deal of careful planning. Here, we were ably assisted by several knowledgeable and dedicated individuals. Our thanks to Michael Heller, Fred Kirschenmann, William Lockeretz, John Luna, James F. Parr, Warren W. Sahs, Richard Thompson, and Ron Voss for their insights and encouragement. Last, but not least, we wish to thank the many anonymous reviewers of the symposium papers. It is our hope that these papers will contribute to ongoing discussions of how best to acquire and disseminate scientifically sound and practical sustainable agriculture information to our nation's farmers. We can think of few more important pursuits.

Responding to farmers' needs: An evolving land grant perspective

John C. Gardner

Abstract. *Farmers and the agricultural research and extension community at the land grant universities have experienced an evolving relationship. The current call for reform in publicly sponsored agricultural research and extension is built upon more than a century of dialog. If specialization and discipline-oriented research is to continue, the ecosystem-based knowledge of the farmer will become increasingly valuable. Involving farmers more actively in research and education could be achieved in several ways. Outside the land grant system, nonprofit agricultural research and demonstration organizations are being developed. Within the public system we need a renewed emphasis on extension at the local level and a revitalized applied research effort aimed at solving problems of the agricultural ecosystem rather than single disciplines. A dynamic and resourceful agriculture could result from including the farmer as a full partner in land grant research and education.*

Key words: research policy, non-profit organizations, extension service, applied agricultural research

"We wish to impress upon the attention of the farmers of the State that this institution belongs exclusively to them, that it receives its income for the sole purpose of being expended in their aid, that in its work their desires and interests will be constantly furthered, and that their interest, assistance, and suggestions are earnestly desired, solicited and expected."

H. E. Stockbridge (1891), North Dakota State University's first president and agricultural experiment station director.

While most land grant universities have historical mandates similar to North Dakota, the relationship between farmers and their publicly supported agricultural research and extension system has been long and complex. The need for dialog has existed throughout the relationship because of changing economic, social, political, and more recently, environmental and health concerns. The farming public and agricultural universities have continually challenged each other on all these issues. If agriculture is to explore new alternatives, serving the rural and urban public, the farmer, and the land, we must strengthen the partnership between farmers and the land grant university system.

An evolving relationship

Meeting the needs of farmers was not the principal motivation behind the Morrill Act in 1862, which initiated the U.S. system of land grant agricultural colleges (Danbom, 1986). The system was devised not by farmers, but scientific professionals, journalists, and country gentlemen. Agricultural production was needed to bolster a post-Civil War economy, and concurrent with the industrial revolution, farmers were viewed as productive assets. The land grant system began under the assumption that the major factor limiting agricultural production was the farmer's lack of scientific knowledge. But farmers didn't see themselves as the problem. In a period of agrarian discontent, they blamed railroads, bankers, and others who were viewed as exploiting them through capitalism (Buck 1913).

The Morrill Act immediately emphasized scientific methods, disciplines, and the foundation for what later resulted in the research, teaching, and extension roles at the land grant university (Jordan et al., 1986). Such a system was undoubtedly used to help buffer the agricultural sciences from social issues and politics, land speculation and business interests, populism, and other attempts to influence land grant colleges during their early years. Individual faculty members then as now, held a wide variety of opinions on what agriculture and farmers needs were. Danbom's (1990) vivid account of H. L.Bolley's experiences over the first forty years at the North Dakota agricultural college surely took place at other colleges as well. Regardless of outward appearance and public perception, social issues and politics seem destined to play a role in agricultural research direction.

The adult educational function of the young colleges was authorized in 1914 with the Smith-Lever Act. Though some states had extension service precursors mostly funded by railroads, bankers, and other agricultural businesses (Danbom 1990), making these organizations public was needed to represent the land grant system at the grassroots level. Extension was to both pass information from the university to the farmer and bring the farmers' needs to the university (Bonnen, 1986). Extension agents were to deliver and convince farmers to use new, improved farming methods while maintaining the integrity and well-being

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John C. Gardner is Superintendent and Agronomist, North Dakota State University, Carrington Research Extension Center, Carrington, ND 58421.

of the local community. Despite seemingly good intentions, farmers were reluctant to have urban agrarians teach them how to farm (Danbom, 1979).

The first major call from farmers for a land grant system more responsive to their needs came during 1925-1935 (Danbom, 1986). This period began with high production and low prices and ended in the Dust Bowl of the Great Plains. For the first time, farmers questioned the social and economic consequences of the technology being developed by the land grant system. Both agricultural industry and the land grant system resisted the allegations, and the results of applying current technologies were regarded as inevitable.

The Dust Bowl was followed by an era of widespread development and application of mechanization, hybrid corn, pesticides, and synthetic fertilizers. Combining these technologies on the farm led to dramatic yield increases. Since private industry was both a major partner and an innovator in the development of these technologies, unlike the period following the Civil War, industry was now viewed as responsive to the needs of farmers (Bonnen, 1986). Professionals representing agrichemical and other companies were more highly trained and skilled at helping farmers with specific production problems than were many extension agents. Partnerships and cooperative research and extension programs between the public and private sector became common.

The most recent call for reform at the land grant universities began with the emergence of growing conservation and environmental concerns. Traced to the writings of Aldo Leopold and Rachel Carson, environmental concerns now joined earlier social and economic concerns. The call for land grant reform came both from outside production agriculture, for example Jim Hightower's (1973) *Hard Tomatoes, Hard Times*, and from within, such as Kentucky farmer Wendell Berry's (1977) *The Unsettling of America*. The 1980's saw growing farmer concern over inadequate agricultural production credit, high production, low prices, a shrinking rural population, soil erosion, and contamination of ground water and food. Ultimately these concerns led to the publication of *Alternative Agriculture* (NRC, 1989), a critical analysis of U.S. agriculture.

The farmer as a research partner

Despite noble beginnings, such as Stockbridge's (1891) first report, the land grant system has become accustomed to viewing the farmer only as a recipient of education. Struggling for agriculture to become recognized as a legitimate field of science, many early 1900's scientists welcomed the movement towards specialization and reductionism (Danbom, 1990). It was thought that "good" agricultural science would only come with the greatest distance between farmer and scientist. The development of the extension service was welcomed as a grassroots organization responsible for educating farmers, relieving those tasks from researchers.

Extension agents were also responsible for bringing the farmer's problems to the university. It soon became apparent, however, that extension could not reach everyone and usually the largest, most progressive, and politically powerful farmers were the first served (Bonnen, 1986). In an attempt to balance public input, particularly after the 1925-35 period of questioning, the discipline of rural sociology was used as the land grant's "conscience" and voice of the common farmer's social needs (Buttel, 1985). With the advancing complexity of society since that time, even further disciplinary subdivision has been needed. The farmer's economic needs have been assigned to the agricultural economist. And, while rural sociologists have remained the land grant "conscience," a new direction is becoming apparent in the growing body of literature on distinguishing farmers who are adopters from nonadopters of new technologies. Though useful and revealing of the farmer's viewpoint and needs, such knowledge could also be considered privileged information and used in a manipulative and abusive manner.

The first serious consideration of farmers serving as valuable research partners occurred in international agricultural development. Farmers must assist if the introduction of very different technologies into relatively undeveloped countries is to be successful. Farming systems research has resulted from bringing the researcher and the farmer together in developing technologies appropriate to specific social and economic settings. Nearly all the criteria that limit the appropriateness of a technology are site specific and individual to each farmer (Winkelmann and Moscardi, 1982). Out of necessity, however, agricultural research must be more general. To be successfully adopted, new alternative production strategies must satisfy the economic and ecological needs of individual farmers.

The value of farmers as partners in research is currently being rediscovered in the U.S. This partnership has largely been fostered by a growing number of nonprofit agricultural research organizations. Until recently such organizations were only tolerated by the research and extension community. Today these organizations are becoming widely recognized for their leadership in representing farmers and their ideas. Though not all in the research and extension system may agree with Iowa's Dick Thompson or North Dakota's Fred Kirschenmann, these farmers and nonprofit organization leaders have undeniable competence and conviction. They and other farmers like them across the country have ushered in a new era and redefined the role of farmers as research partners. The emphasis on farmer participation in the federal Low-Input Sustainable Agriculture (LISA) research and education program is a testimony to their success.

Building farmers as partners into the land grant system

Though the land grant system has on occasion been criticized for not being responsive to the farmer's needs, it can also be said that it has been too responsive. Anxious about keeping public support and funding, it first tries to solve the production problems voiced by the most influential farmers. Often, these problems have been quickly solved with additional inputs. Over time, it is becoming

increasingly evident that these quick remedies are treating the symptoms but not the root of the production problem (Buttel, 1985). For example, diseases, insects, and weeds are all adapting to high level of selection pressure exerted by continuous application of similar pesticides. Breeding crops with a narrow genetic base for resistance to a particular disease or insect is also proving to be a short-term solution.

The land grant system has sought ways to incorporate the great diversity of ideas from farmers. Sociologists and economists have developed methods to detect the critical needs of farmers as a group, not just the most vocal ones. Formal surveys are a way to cover a large population, while informal surveys are used to assess the needs of individuals (Franzel, 1986). Extension, particularly the local county agent, has been another way that the research in the land grant system has been influenced by farmers' needs.

Another important way farmers can be included in the research effort is through the out-state research centers operated by most land grant universities. Depending upon the state, such contact can result in farmer partnership in demonstration and research at the local level. This contact in turn feeds back to the university through extension, the experiment station, and finally the discipline-based departments.

There has been a declining interest in applied research and a lack of adequate funding for out-state experiment stations in most states, however. As disciplines become more specialized, fewer scientists are interested in such research sites because they are perceived to lack status and not lead to peer-reviewed publications. Over time, this has resulted in scientists on the main campus to have a general lack of confidence in the personnel and research done at out-state stations (Buttel, 1985).

A recent survey of out-state experiment station administrators revealed their concern over retaining adequately trained scientists and the trouble they are having in maintaining a balance between more specialized, discipline-based research versus field-oriented applied research (Anderson and Thompson, 1989). Applied research does not attract as much competitive grant funding as does more basic research. Further, the survey revealed that researcher/farmer relationships are often valued more as a way to gain public financial support than as a way to guide research direction.

Experiment station administrators have recognized the need for a renewed emphasis on applied research and out-state experiment stations to complement the increasingly specialized and basic research coming from the land grant universities (Holt, 1987; Feltner, 1988). Out-state research sites offer distinct advantages for understanding farmers' needs and involving them as partners in research. Unlike university sites, being located at an out-state center assigns the scientist to an ecosystem as much as a discipline. Most sites have small teams trained in various disciplines of crop, soil, and animal sciences; because they are small, they are highly interactive. Also, the scientists themselves live in the same ecosystem and community as the farmer. Both peer and social interaction are important in determining the goals, outlook, and values of agricultural scientists in general (Busch and Lacy, 1983). With fewer agricultural scientists coming from rural backgrounds, it will become even more important for them to gain firsthand knowledge of production problems through experience.

Because land grant research has lacked an overall understanding and knowledge of agricultural ecology and of specific agroecosystems (Jackson and Piper, 1989), a renewed emphasis should be placed upon the historical structure of out-state experiment stations. These are sites where the farmer's valuable knowledge of the ecosystem and skill of adapting to it can be most easily communicated and researched.

Many land grant institutions have responded to the need for exploring these alternatives by creating "centers" or departments that have sustainable agriculture as their goal (Lamm, 1989). Although a few of these will be valuable for gathering resources and coordinating information, particularly at the larger universities, at most land grant institutions such departments will only continue past specialization and fragmentation of faculty. If the current interest in sustainable agriculture is justified, the responsibility for studying the alternatives rests upon all scientists, not just those in "sustainable" departments.

While earlier times set the precedent for farmers to have a lesser role in the land grant system, it now seems appropriate to again actively solicit and expect their involvement. As science becomes more narrow and discipline oriented, farmers' knowledge of specific ecosystems will be important in the development of future agricultural production systems. For land grant universities to better assess, investigate, and apply appropriate technologies, farmers should be made partners in both research and extension. This will require a renewed commitment to university faculty who are employed at the local level in ecosystem-oriented and applied settings. Their role must be clarified in balancing and complementing the discipline-oriented staff on campus. Further cooperation with nonprofit research and education organizations should also be encouraged. And lastly, the land grant system as a whole must revive its historical link to the people by attentively listening to their needs and respectfully observing their skills. Though the relationship between farmers and the land grant university has evolved over time, it must remain one of mutual respect.

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RESOURCES

1991 Organic Supplier Directory is cross-indexed by suppliers and products and includes national coverage with a regional Ohio focus. Published by the Ohio Ecological Food and Farm Association, copies are $25 for Association members and non-profits and $50 for non-members. Contact the Association, 65 Plymouth Street, Plymouth, OH 44865.

Guide to the U.S. Organic Foods Production Act of 1990 is a guide to the new federal organic law, published by the Organic Foods Production Association of North America. Cost is $7.50 plus $2.50 shipping and handling, with a discount for Association members. Contact Stuart Fishman, 5628 SW Miles Court, Portland, OR 97219; (503) 245-2309; or the Association, P.O. Box 1078, Greenfield, MA 01301; (413) 774-7511.

1991 Briefing Book is a 160-page book on current environmental and energy legislation and laws prepared for members of Congress and their staffs by the Environmental and Energy Study Conference. The material is published outside Congress by the Environmental and Energy Study Institute. Copies are $50 each. For copies, contact the Institute, 122 C Street, SW, #700, Washington, DC 20001; (202) 628-1400.

Farming for the Future is a new booklet-video series on sustainable agriculture from the Land Stewardship Project. The four booklets are "Mechanical Weed Control," "Nitrogen Management," "Controlled Grazing," and "On-Farm Composting" cost is $4 each or all four for $12. The four videos are "Rotary Hoe," "Nitrogen Management," "Rotational Grazing," and "Cover Crops" cost is $25 for the first copy, $20 for each additional copy. Contact Land Stewardship Project, P.O. Box 815, Lewiston, MN 55952; (507) 523-3366.

Analysis of action on the state level is contained in **The Harvest: State Strategies for Sustainable Agriculture,** published by the Center for Policy Alternatives. Copies are $15 from the Center, 2000 Florida Avenue, NW, Washington, DC 20009.

Farm Program Options Guide, a 32-page booklet on the sustainable agriculture and conservation provisions in the 1990 Farm Bill, is edited primarily for farmers. About half of the booklet is devoted to the Integrated Farm Management Program Option and other flexibility options. Write: Farm Guide, Center for Rural Affairs, P.O. Box 405, Walthill, NE 68067. Send $3 for printing, postage, and handling.

Farm Animal Welfare: Crisis or Opportunity for Agriculture? is an examination of the animal welfare issue for farm and non-scientific readers. Published by the University of Minnesota, Department of Agricultural and Applied Economics, copies are $6 from the Department, 213 Classroom Office Building, 1994 Buford Avenue, St. Paul, MN 55108.

Sustainable Agriculture: A Brighter Outlook for Fish and Wildlife, a new report by the Izaak Walton League of America, concludes that sustainable farming practices, such as reduced use of chemicals and a greater diversity of crops and livestock, would significantly benefit fish and wildlife. For more information, contact Ann Robinson at the League, 801 Commerce Drive, Decorah, IA 52101; (319) 382-2947.

From the Ground Up is a publication documenting techniques as well as case studies of Wisconsin farmers using alternative farming methods. It is available by writing the Wisconsin Department of Agriculture, Sustainable Agriculture Program, P.O. Box 7883, Madison, WI 53707 (or phone 608/267-3318).

Involving farmers in agricultural research: A farmer's perspective

Kay Thornley

Abstract. *Farmer involvement in agricultural research is limited by inadequate funding, institutional policies and hierarchies, disciplinary specialization, and incompatible personalities. Additional barriers include academic emphasis on carefully controlled experiments, research priorities driven by personal interest, and farmers' reluctance to disclose trade secrets. Priorities for research conducted with public funds should be identified through a democratic process involving representatives from all sectors of agriculture. A broad, multidisciplinary, systems approach to agricultural research is needed; and farmers and researchers should consider long-term implications of projects. Better balance needs to be achieved between basic and applied research, and both should encourage innovation within the context of democratically determined research priorities. Opportunities abound for involving farmers in research as providers and recipients of information, as participants in determining priorities and ensuring practicality of methods, as collaborators and/or subjects for on-farm investigations, and as project evaluators. Farmers also need to take more initiative in getting involved in the political processes that set the stage for agricultural research.*

Key words: publicly supported research, research oversight, research priorities, whole farm research, information management

In discussing the vitally important topic of involving farmers in agricultural research, I will confine myself to comments regarding research that occurs with public financial support--that is, with taxpayers' money. There are other arenas for the conduct of agricultural research, from field trials of individual farmers, to nonprofit research institutions, to the massive research and development efforts of multi-national corporations. Though these efforts sometimes overlap publicly supported research, most research conducted in other arenas is autonomous, and a symposium such as this will have little opportunity to influence it. Therefore, my comments apply only to research in the land grant universities and other public institutions of higher education and within the 'S' acronym network: the ARS (Agricultural Research Service), CSRS (Cooperative State Research Service), CES (Cooperative Extension Service), and SCS (Soil Conservation Service).

Why involve farmers in research?

There are two basic questions about the need to involve farmers in publicly supported agricultural research: 1) Why do we need to do it? and 2) What must we do to get more of it?

When I asked several friends the first question, my favorite response was a simple one: "So the researchers know what they are supposed to be doing and how they are supposed to be doing it."

Obviously, this friend was a farmer, not a researcher. But the answer covers the basic concerns about the relevanc and applicability of research. Some ag ricultural research will directly benefi farmers; it is logical that they be in volved. Other agricultural research ma be for the benefit of other specific con stituencies or the general public. Eve so, farmers are likely to be affected i some way and therefore should still b involved in the research process.

Just as it seems self-evident why w need to involve farmers, so too it seem self-evident how to get more of it: re move the constraints that prevent or im pede farmer involvement. I will discus first the constraints covering need within the context of each constraint s that I can conclude positively by dis cussing opportunities.

I don't pretend to know everythin about current involvement of farmers i agricultural research; but from my ow experience, I feel safe in saying there ought to be more of it. During my ow involvement, I have noted many obsta cles that range in scope from institu tional structure to personality traits Some seem insurmountable, others al most trivial. I hope that cooperatio among people such as those in this sym posium will remove the constraints an thereby improve our agricultural re search establishment.

Constraints on farmers involvement

An overriding constraint that aggra vates almost all others is the inadequat funding level of agricultural research Agriculture receives only about four per cent of federal research funds. This i disturbingly low, considering that ther is no more basic social need than th business of food. Increased funding cer tainly will not guarantee more farme

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Kay Thornley is an organic vegetable farmer in Davenport, CA 95017.

involvement, but it could help considerably, particularly if funding agencies earmark funds for such projects.

However, funding increases must be accompanied by formulas for their equitable distribution. Narrowly focused commodity interests tend to be the primary beneficiaries of publicly supported research. Private funding for research topics chosen by those sources leverages public funds. Thus the research agenda for private and public funds is predominantly dictated by private interests, which in turn are primarily driven by the desire for increased profits. Instead, the agenda for research conducted with public funds must be dictated by public interests and must address research priorities identified through a democratic process. In that process, we must insure that concerns about people are integrated with concerns about profit and production.

Aside from financial concerns, the most glaring constraints to the involvement of farmers in research lie in the organizational structure of our research institutions. The agencies and institutions involved in agricultural research all have a top-down hierarchy, and farmers most often are on the bottom if they are involved at all. The result is a system where too many decisions are based on power and politics instead of reason and relevance.

Sometimes farmers serve on advisory committees, as I do for the University of California Sustainable Agriculture Research and Education Program. This can give the illusion of being at a higher level of authority, but "advisory" means exactly that: my advice can be followed or ignored at the sole discretion of those with decision-making power. What we need, then, is to democratize our research institutions; we need a restructuring that equitably distributes authority among representatives of all sectors of the agricultural community, from farm workers to consumers. Participating farmers need to represent the full range of farm size, income, crop specialization, ethnicity, and sex. Women and minorities are greatly underrepresented in the agricultural research arena when compared to their numbers in agriculture as a whole. The further I go from the field toward the bureaucratic centers of agriculture, the more striking the underrepresentation becomes. Farm workers are even more underrepresented. Yet frequently it is farm workers who are most directly affected by changes resulting from research.

A second structural constraint to farmer involvement in agricultural research is the academic reward system. Researchers get promoted for rigorous and replicable experiments. Since farmers are not an easily controlled variable, they seldom fit into the scope of academic research. For reasons that have always escaped me, basic research is worth more than applied research in the tenure review process. We need not debate the relative merits of basic versus applied research: both are crucial to the progress of agriculture. We need balance and a promotional system in academia that recognizes, encourages, and rewards excellence in both. Also, farmers need to gain more appreciation of the vital role of basic research in laying the foundation for creative new options in applied research.

Another structural constraint that is directly related to the basic versus applied research issue is disciplinary specialization in research. Farmers are generalists; we think in terms of whole farms, with all their interactions and interdependencies. We need to know at least a little about many different subjects. Researchers, on the other hand, become increasingly specialized in their knowledge. Their research reflects a reductionist perspective, typically investigating a single phenomenon in isolation. This leaves little room for farmer involvement. In my opinion, reductionism has been the source of many problems in agriculture. Farming does not consist of isolated phenomena. It is a complex interactive system, and we need more researchers qualified to analyze whole systems. Farmers must be recognized as integral parts of those systems and therefore must be involved in the research. We also need incentives for interdisciplinary research so that specialists will work together on research projects more often, thereby gaining a better understanding of the interrelationships among components of agricultural systems.

A similar constraint requires some changes on the part of farmers. Too often in meetings I attend with farmers concerning agricultural research, I see a different sort of reductionism. Farmers tend to focus on their own farms and the particular problems they face. This is perfectly understandable and appropriate, but farms also do not function in isolation: they are part of a social, economic, political, and environmental context. We need more farmers involved in research who look beyond the farm gate and recognize the importance of broader social concerns and national and global influences that affect agriculture.

We also need the involvement of farmers and researchers who look beyond the immediate future and who do not want to see our research efforts forsake long-term productivity in favor of short-term production. We all need to consider the health and well-being of future generations when we plan and implement agricultural research.

One more constraint posed by academia is a somewhat nebulous thing called "academic freedom." My translation of this term is that researchers don't want anyone telling them what they ought to be doing. Any demands for research accountability and responsiveness to farmers' needs are perceived as threats to the creativity of researchers. "Science for science's sake" is the popular defense. No one wants to stifle scientific genius; we certainly need innovativeness in agricultural research. But we also need to have scientists focus their work on priority issues identified through a democratic process.

Besides these institutional constraints, some personal characteristics of researchers and farmers also create barriers to more farmer involvement in agricultural research. The first of those characteristics is what I call academic egos. Many researchers exude an air of superiority that generally intimidates or infuriates farmers. At the same time, farmers are the stubbornly independent sort who like to think that they don't need anyone for anything. This personality clash strains communication and cooperation. Several times I have heard the dialogue deteriorate to claims by the re-

searchers that farmers just don't understand anything about rigor in scientific research, to which farmers quickly reply that researchers just don't understand anything about farming. That kind of exchange benefits no one. We need researchers and farmers who recognize the strengths and weaknesses of the other and realize that the greatest good will come from mutual respect and cooperation.

My farmer bias leads me to say that it would help immensely if all agricultural researchers had some practical farming experience. To some extent, farmers are almost always researchers, however much they lack scientific rigor. But it is not uncommon to find researchers who have never worked on a farm. We need to require that researchers get some practical experience as part of their educational program. Likewise, we need to promote farmers' knowledge of research design and techniques.

Another character trait that impedes farmer involvement in research is that both researchers and farmers tend to be 'Type A' personalities. Both always seem to have more to do than is humanly possible. Getting farmers to leave the demands of their farms to attend meetings or visit research plots is always a challenge, especially during harvest season. Likewise, it is difficult to get researchers to leave the demands of their laboratories and experimental plots to visit farms and meet with farmers.

We may need drastic measures to overcome this constraint. As a start, we should require that every agricultural research project be reviewed by a farmer prior to funding approval. That would force communication on the part of the researchers. We cannot force farmers to participate, but we can certainly encourage them by acknowledging the value of their contribution and remunerating them accordingly. Researchers and bureaucrats need to recognize that, unlike them, most farmers are not on a salary. Income is a direct consequence of time spent farming. My tomatoes do not produce more because I spend time reading grant proposals, giving speeches, and attending meetings. Not only do I lose my own income, but during busy times of the year, I have to pay someone to do the farm work in my absence. Certainly there are more than economic reasons for farmers to get involved, but volunteer contributions only go so far. Paying farmers for their participation in agricultural research would do much to promote a climate of mutual respect.

The final constraint comes from the farmers and has to do with "trade secrets" and proprietary interests. I have often heard farmers express reluctance about getting involved in research for fear they may lose their competitive edge if their farming techniques or specialty crops are "discovered." Many are understandably protective of information generated by research that they had to conduct on their own because public research agendas were driven by private interests with different needs. I see no way to overcome this constraint. Farmers have every right to keep their knowledge to themselves. Fortunately, I believe that many farmers are concerned enough about other farmers and the overall future of global agriculture that they will participate willingly in research to validate and disseminate their farming strategies.

This discussion of constraints and needs does not exhaust the list. There is no question that overcoming these constraints and meeting these needs will be a challenge for all, but I don't want to be too discouraging. The good news is that today's agricultural climate bodes well for meeting the challenge.

Information Management

First, it seems generally accepted that agriculture is entering a new era. We had the animal power era, the mechanical era, and the chemical era. Now we are heralding the era of information management. This is a positive shift that creates numerous opportunities for farmer involvement in research. Farmers can contribute a wealth of information and they can use a wealth of information to assist them in meeting the challenges of today's dynamic and uncertain agricultural system.

Connected to this shift toward information management, and perhaps a major impetus for it, are the growing public concerns about the environmental and health effects of current chemical intensive production practices. At the same time, farmers are increasingly concerned about the rising costs of chemical inputs. The need to explore alternatives has increasingly been accepted, and now the consuming public has forced all sectors of the agricultural community to recognize that need. "Alternative" agriculturalists are no longer passed off as the lunatic fringe. The spirit of cooperation in facing the new challenges affecting us all is conducive for involving farmers in agricultural research.

Perhaps the most basic opportunity for such involvement is to include farmers when identifying research needs and setting priorities. This can be achieved in various ways, such as needs assessments, informal discussions, or advisory and review committees. The Public Advisory Committee of the University of California Sustainable Agriculture Research and Education Program is one model for this type of farmer participation. Farmers and other public representatives on this committee recommend funding priorities, review grant proposals, and identify projects that they believe are most worthy of support. Offering farmers some decision-making authority as well as some monetary compensation for their participation is highly desirable. Also, there must be democratic representation in this process. When identifying needs and establishing priorities, we need to include the full range of constituents affected by agricultural research, not just farmers, but also consumers, environmentalists, manufacturers of agricultural products, and many others.

Whole farms as research systems

Another opportunity for involving farmers in agricultural research is for them to be the subject of investigations. This type of involvement should go beyond mailed surveys to include research that examines whole farm systems. Documenting what is occurring on operating farms can provide valuable insights and help identify specific areas of research that need to be pursued.

As one researcher recently put it to me, researchers go at things backwards

"We start in our laboratories and experimental plots and generate some strategy or technology that we then take to the farmer's field. What we should be doing is going to the farmer's field first to identify what needs further study in our laboratories and experimental plots."

I am encouraged that exploratory research as suggested by this researcher may even be able to survive academic peer reviews for scientific rigor. That is because of the rapidly expanding data processing capabilities of computer-based statistical analysis. Using sophisticated data processing programs, researchers now can examine many variables simultaneously to see what patterns emerge and to identify topics for more rigorous investigations.

This same kind of involvement lets farmers be a source of background information for researchers. Customarily, a researcher first conducts a literature review to see what has already been done in a particular area. A wealth of information is available in the minds of experienced farmers--farmers who have been experimenting and innovating on their own for many years. Tapping this source must proceed quickly because there are many older farmers in this category whose wisdom will be lost if we procrastinate.

A fourth opportunity for involvement is for farmers to become collaborators on research projects, such as by advising the researcher in the design of experiments to insure that cultural practices reflect the realities of farm operations. Because so many farmers are now converting their farms to low-input and organic practices, there are many exciting opportunities for going beyond the advisory level to bring scientifically valid research projects to the farm. In many cases, farmers are already conducting side-by-side field trials on the conversion process.

Similarly, there are opportunities for researchers to offer guidance to farmers in conducting their own research. Farmers frequently conduct field trials anyway, but seldom with the scientific rigor that makes results acceptable to researchers. In some cases, workshops on experimental design, and on data collection and analysis could make these on-farm research projects scientifically credible.

Farmers can also become involved in the assessment of technologies and management strategies developed by researchers. Generally, researchers are reluctant to disclose information until results are "proven." Researchers don't seem to recognize that the only real proof is on the farm, and the sooner that they try a strategy there, the sooner it will become credible to farmers.

In a less active role, farmers can become evaluators of research projects. In the Western Region, the LISA Administrative Council recently completed site visits to each major research project receiving funds. I requested that a farmer be included on each site visit team and was fortunate to be a member of such a team. As a result of my participation, the researchers learned about variables in packing procedures that they had neglected to consider in the economic analysis questionnaire that they were about to distribute. I am now convinced that every research project should be evaluated by a farmer, just as each is evaluated by peers in the research community.

Historically, the most common involvement of farmers in agricultural research has been as recipients of research information. The researcher, through cooperative extension staff, enlightens farmers about research developments and teaches them how to apply the latest findings on their farms. The opportunities for this kind of involvement are greater today because there are so many new young farmers taking over the farms of those reaching retirement age. Also, whether new or experienced, all farmers are hungry for information that will help them meet today's challenges. Creative ways must be devised to meet the information needs generated by an agriculture in transition.

One final and all-important opportunity for farmers to become involved in the research process is through politics. As much as I hear farmers trying to deny it, agriculture is as political as it is biological. Farmers can bring about changes in agricultural research by getting involved in legislation, budget hearings, political campaigns, and research bureaucracies. In California, farmers were the primary constituency behind the passage of SB872, which mandated the creation of the University of California Sustainable Agriculture Research and Education Program. Farmers continue to lobby, although with limited success, for increased funding for that program.

Farmers were once well represented in the political process because they were the majority. Politicians knew that their election depended in large part on meeting farmers' needs. Today, with less than four percent of the population working on farms, politicians are not so concerned about them, therefore, farmers need political allies. Fortunately, the voting public is genuinely concerned about the well-being of American farmers. Who wouldn't be after movies like *Country*, *Places in the Heart*, and *The River*? Fortunately for proponents of alternative agriculture, there also is strong public support for finding ways to produce food that better protects human and environmental health.

But it is clear that farmers must start working harder in the political arena to make their needs known and to demand political support for programs that will meet those needs. There are opportunities to do this at the local, state, national, and even international levels. More farmers need to avail themselves of those opportunities and to take a stand on what matters most to them.

Expansion of USDA food safety programs sought

The Bush Administration has proposed an expansion of the USDA multi-agency food safety initiative that collects and analyzes pesticide residue data. Overall, the USDA wants to expand its food safety programs by more than 25 percent, with a budget increasing from $97 million this year to $123 million next year. Eight USDA agencies are involved in the initiative.

Farmers' role in sustainable agriculture research

William Lockeretz and Molly D. Anderson

Abstract. *Involvement of farmers in sustainable agricultural research can have important benefits, since farmers originated many sustainable agriculture innovations and can contribute a valuable perspective different from that of researchers. However, this does not mean, as is sometimes said, that all kinds of sustainable agricultural research necessarily should give farmers a major role—perhaps the dominant role—in choosing topics and overseeing the work. This belief overlooks the fact that farmers are just one of many groups that publicly supported research is supposed to serve and that their interests do not by themselves embody the full range of goals that sustainable agriculture tries to achieve. Moreover, although farmers can bring valuable insights to research, these alone will not be enough to insure that a sustainable agriculture research program has an appropriate mix of applied versus basic, short-term versus long-term, and component-level versus system-level studies.*

Key words: on-farm research, low-input agriculture, demonstration projects, land-grant colleges

Introduction

The growing interest in sustainable agriculture in recent years has been accompanied by calls for a much greater role for farmers in choosing research topics, and perhaps also in designing, carrying out, and evaluating specific projects. For example, according to Krome (1988), sustainable agriculture research "should involve farm families in all possible stages... Farmers should be included in an advisory capacity to the overall research program." Similarly, a "guiding principle" of the USDA Low-Input/Sustainable Agriculture program is that "meaningful participation of operating farmers...is essential to the success of this approach" (USDA, 1988).

The coupling of sustainable agriculture to a greater role for farmers in research also can be seen in the increasing popularity of projects conducted on working farms. Putting research on a working farm does not necessarily mean giving the farmer an important role, but in recent years this has increasingly been the practice. For example, in the large and well-known on-farm sustainable agriculture research program run by the Rodale Institute, "farmers and spouses [are] responsible for the majority of the research ideas" (Edwards et al. (eds.), undated, p. 7).

This recognition that farmers have much to contribute to agricultural research is a welcome change from an attitude that once was much more prevalent. Traditionally, farmers were little more than the passive, and at first even the reluctant, recipients of the products of agricultural research (Danbom, 1986). Their ideas on what subjects should receive research attention might influence priorities in a general way, but it was uncommon for them to be involved in the detailed design or evaluation of specific projects. The current interest in increasing farmers' involvement in agricultural research is a healthy challenge to the view that researchers have nothing to learn from them. But that does not automatically mean that all kinds of sustainable agriculture research should give a major role to farmers; this paper discusses both the benefits and limitations of this principle.

The connection between sustainable agriculture and farmer involvement in research

Why the call for a greater role for farmers in research should be particularly associated with sustainable agriculture is not always made clear: instead of being explained, the connection is often just declared or made a matter of definition. Nevertheless, several strong reasons are apparent. One is that many innovative sustainable techniques have originated with farmers; the experience and creativity of these farmers clearly can make a valuable contribution (Krome, 1988). Also, according to some people, sustainable systems entail a distinctive way of thinking about farming, one that researchers may not be familiar with. If so, they will get a fuller understanding of the system they wish to study if they have direct contact with farmers. A third reason is that sustainable agriculture is commonly said to involve more active and sophisticated information management by farmers (Francis and King, 1988). If so, the human element must receive more research attention than for systems that can be delivered to farmers as a self-contained

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William Lockeretz is Research Associate Professor and Molly D. Anderson is Research Assistant Professor, School of Nutrition, Tufts University, Medford, MA 02155.

technological package; information on farmer management "can only be obtained by on-farm research" (Edwards et al., (eds.), undated, p. 4). Still other reasons are related not to the role that farmers play in the research, but to the benefits of using working farms as the site for sustainable agriculture research, regardless of whether the farmers participate heavily. Conditions on working farms are different from those of experiment stations, so that research is strengthened when it is done on both kinds of sites (Lockeretz, 1987). Also, using several working farms allows the research to cover a much wider range of soil types and other variables. This argument applies to many kinds of research, but it is especially important to sustainable agriculture because an important idea in sustainable systems is the need for flexibility in adapting to the specific conditions prevalent on a particular farm.

These reasons for the increasing interest in sustainable agriculture to be connected with a greater research role for farmers are reinforced by the fact that the same people often are interested in both. Support for both kinds of changes reflects a concern for restoring a "grass-roots" orientation in publicly funded agricultural research and freeing it from irrelevant or corrupting influences. These influences, on one hand, include manufacturers and suppliers of production inputs; sustainable agriculture is a way to reduce their influence because it usually is identified with "low-input" agriculture. Another such influence is researchers who are considered to have lost touch with the needs of their presumed clients (i.e., farmers) and are thought to select research topics with an eye more on career advancement and monetary rewards than on the value of the work to farmers. A greater role for farmers in choosing the topics and judging the value of research is an obvious way to correct this perceived defect. This issue is especially significant for sustainable agriculture because support for sustainable agriculture has in part arisen out of a conscious protest by outsiders, including some farmers and advocates for farmers, against the research priorities of the agricultural mainstream. No doubt it is galling to lose control over an idea that one has struggled to gain acceptance for, especially if some of the people who now have control over it initially opposed it and cannot necessarily be relied on to carry it forward in the same spirit as its original proponents.

Another less direct connection between sustainable agriculture and farmer involvement in research arises because farmer groups interested in sustainable agriculture often apply the term "research" to projects that traditionally would have been considered demonstration, extension, or training activities (Lockeretz, 1987). Obviously, farmers are an essential part of this kind of activity.

The appropriate role of farmers in influencing and participating in sustainable agricultural research raises several questions. First comes a matter of definition: What is research? After contrasting the various senses in which the term is now used, we consider several substantive questions that have not always been addressed as explicitly as they deserve to be: Whom is publicly funded agricultural research supposed to serve? What issues should sustainable agriculture research cover? What kinds of research "products" should it try to develop?

What do we mean by research?

As the term is generally used by researchers, and as we use it in this paper, research means more than simply an activity that seeks to answer a question. The answer must not already be known by anyone; it must interest other people besides those engaged in answering it; and it must add to a cumulative body of knowledge.

Today, the term is also used for some sustainable agriculture activities that do not meet these criteria. For example, demonstration projects involve questions that have already been answered, their purpose being to inform farmers about them or to encourage them to make certain changes. The term has also been applied to individual farmers' investigations of questions that are specific to their farms, or that they answer in a way that is specific to their farms. Farmers have always done such investigations, either to solve problems or to evaluate to their satisfaction an innovation suggested by someone else. The only new aspect of such investigations is that more help is now available to show farmers how to do them better. (Interestingly, when experiment stations were first established, many farmers saw their role as conducting experiments that individual farmers did not do only because they lacked the time (Rosenberg, 1971).) Appropriate procedures for this purpose typically will be very different from those that seek to add to a general fund of knowledge, and failure to keep these differences in mind can be detrimental. Farmers may get impatient with researchers' insistence on replication, adequate controls, and other design requirements that seem to stand in the way of just getting on with the job of answering the question. Some go further to look for the villain behind such nonsense. A common candidate is "they do those things just so they can get published."

Finally, another kind of research-like activity is intended not so much to answer a question as to improve farmers' ability to answer questions themselves. This is analogous to a student laboratory exercise (often called "research" too), where the teacher already knows the answer; the point is for the student to learn how to answer similar questions in the future. Often this kind of project includes establishment of a farmer network for exchange of information. This is intended to allow farmers to become less dependent on external, institutional sources of expertise, in keeping with the "grass-roots" orientation of some sustainable agriculture groups discussed earlier.

Farmers clearly have a crucial role to play in these activities. But in discussing the role of farmers in research, it is important to distinguish the activities just described from research in its more traditional definition. The distinction often is not heeded. This may lead to generalizing, unconsciously or not, from the important role of farmers in some research-like activities to the belief that farmer involvement is appropriate or even essential for all kinds of research,

whatever its scope and purpose.

Publicly funded agricultural research: For whom?

This very important question does not often come up for much debate, at least not in arguments that farmers should have an important role in influencing research. The presumption that the primary mission of the public research system is to serve farmers in turn becomes the justification for that role.

Historically, publicly funded agricultural research at the land grant colleges—the "people's universities"—was begun with a clear commitment to serving farmers. Granted, there often has been considerable controversy over what "serving farmers" means, especially because serving certain kinds of farmers sometimes means causing others to suffer, and because research institutions may promote their particular choice from among several legitimate agricultural ideals (Kirkendall, 1986). Those who disapprove of the choices that actually were made have criticized the research system for straying from its historic mission, but the main criticism has been that the system doesn't fulfill its mission, not that serving farmers shouldn't be its mission.

But public agricultural research's mission and its obligations to farmers is a more complicated question. When the research system was established, "serving farmers" did not simply mean doing things that farmers would benefit from: as Danbom (1986, p. 110) commented, the people who established the system "spoke of doing something for the farmer, but their main goal was a productive agriculture which would strengthen the nation." It is interesting that the conflict between the two was clear from the start, even though at the time the country was overwhelmingly agricultural. Moreover, "doing something for the farmer" definitely did not mean doing the things farmers said they wanted. If it had, there might not have been a system at all, since many farmers originally were opposed to agricultural research (Danbom, 1986). And it certainly did not mean getting farmers involved in the details of research. Very early, an accommodation was reached in which researchers kept control over the research process, but won farmers' support by emphasizing highly applied work of immediate utility to farmers (Schweikhardt and Bonnen, 1986).

Of course, despite their initially antagonistic attitude, farmers now accept the idea of land grant and USDA research on their behalf. Granted, their attitude remains ambivalent, especially toward federal research that increases aggregate production and therefore lowers commodity prices (Buttel and Busch, 1988). Still, farmers are largely in the role of clients, and in some views the primary clients.

But the money for publicly funded research still comes from everyone, and everyone is still affected by both its intended and unintended results, sometimes favorably, sometimes unfavorably. If farmers are supposed to be the main beneficiaries of public research, the research money spent per beneficiary is very high compared to other sectors of the economy and compared also to the early days of the system. Historical precedent aside, can farmers expect their special client status to continue indefinitely? Is there an entitlement to a large research establishment oriented toward farmers' needs, and if so, how well is it likely to withstand federal and state budget pressures? The conventional answer to the challenge implicit in these questions is still, as in the early days of publicly funded research, that the nation as a whole is the real beneficiary of agricultural research. No doubt it is. But one can't have it both ways. If the benefits to the nation are the reason the nation should be willing to pay for agricultural research, then one cannot also argue that farmers should have the main voice in shaping that research because they are the ones it is supposed to serve.

The question "For whom?" has an ironic twist when it is applied to sustainable agriculture in particular. Much of the current interest in the topic, and much of the willingness to spend money on it, was stimulated by groups outside the farm sector. Even before the term "sustainable agriculture" became widespread, its basic ideas were being advocated by environmentalists, people concerned about toxic residues in food, and rural activists interested in questions of social and economic equity that go beyond purely production-related considerations. These were the issues constituting the "new agenda" of the 1960s and 1970s (Paarlberg, 1980) that was effectively promoted by the "externalities/alternatives" coalition (Hadwiger, 1982) often against strong opposition from some farmer groups.

Of course, many farmers are strongly committed to sustainable agriculture too, and they have made an important contribution both as individuals and as members of the growing number of sustainable agriculture organizations. But if we want to assert as a general principle that agricultural research is mainly supposed to serve farmers, that means all farmers. It doesn't mean just "the right kind of farmers," or "farmers who want the same things we want." If research priorities were really chosen according to the preferences of **all** farmers, how much sustainable agriculture research would we have today?

Sustainable agriculture research: What should it try to achieve?

The question "Who should be the beneficiaries of public agricultural research?" leads in turn to the questions of what it should encompass and what kinds of results it should strive for. When asked regarding sustainable agriculture in particular, these questions may come into serious conflict with giving a greater role to farmers in choosing research topics and designing research activities.

By definition, sustainable agriculture takes into account the long-term consequences of production methods. It also attaches more importance to reducing adverse environmental and socioeconomic effects. Finally, sustainable systems are usually described as being based strongly on the complex principles governing agroecosystems (Stinner and House, 1987).

These characteristics mean that sustainable agriculture research—in aggregate, although not necessarily each indi-

vidual project—should differ from a conventionally oriented program in several important ways. It should run long enough to evaluate how a system will affect future agricultural productivity; for some variables, such as soil organic matter content, this could take much longer than measuring profitability. Secondly, it should be broad in scope, extending beyond the farm's boundary to encompass the local environment of which the farm is a part, and beyond that to the larger economic system (Lowrance et al., 1986; National Research Council, 1989). Finally, it should strive for a better understanding of the interactions among the many elements that make up a farm: not just its various enterprises and production activities, but also its soils and biota (Edwards, 1987). The hope is that this understanding will then lead to improved production systems. These systems will be based on beneficial integration of the farm's components, instead of involving just single products or single techniques (Francis et al., 1986; Stinner and House, 1989).

Yet the sustainable agriculture research programs that give farmers the dominant role in choosing research topics typically do not measure longer-term or off-farm effects on environmental quality, resource depletion, agricultural structure, and rural communities. Although the farmers no doubt are very concerned about these issues, as far as what actually gets studied, these programs tend to ignore the same areas that advocates of sustainable agriculture criticize the research establishment for ignoring. Instead, they deal mainly with tangible, short-term problems for which farmers hope to receive immediate solutions, such as a better way to control a particular weed. Sometimes they do not even aim at developing a better way to do anything, but simply compare various techniques or materials so that farmers can select the best from what is already available. This is the kind of work that farmers demanded when the experiment station system was first established under the Hatch Act (1887). To free the system from this very limited function and to allow its full scientific potential to be fulfilled, later legislation (the Adams Act of 1906) specified that the job of the system was to do "original" research, which the system's federal overseers interpreted as not including simple comparisons of various products (Rosenberg, 1964). Therefore, even though the Hatch Act is the one that is always mentioned in discussions of a system that contributed so much to America's agricultural progress and that earned such an enviable reputation worldwide, the Adams Act is the one that allowed the stations to work in the way that earned that reputation.

Farmers' preferences in research priorities are very understandable, to be sure. Farmers are in a difficult and uncertain business, and it hardly is fair to expect them to give more weight to problems that might affect other people a long time from now than to problems that already are affecting their own farms and that perhaps are even threatening their ability to remain in their chosen occupation. Also, it is understandable if farmers, whose background and experience are different from those of researchers, suspect careerism as the main motivation when they see research that does not seem helpful, even if eventually it proves to be very valuable to them.

But to say that it is understandable for farmers to want certain kinds of research is not to say that farmers' expressed preferences should necessarily be the main consideration in designing a sustainable agriculture research program. Suppose farmers choose not to give high priority to the characteristics that define a truly sustainable agriculture. Does this mean that we should just drop them? If the researchers are well-respected and trusted by the area's farmers, for example because of successful extension work, perhaps they can gain farmers' support for research whose benefits are not so direct or apparent. However, some research groups—whether to avoid being labeled as elitist or because they believe very strongly in the doctrine of "farmers first"—would regard even this as too heavy an intervention. In any case, persuasion will not always work, leaving us with the very difficult problem of resolving conflicting priorities.

Conclusion: The complementary roles of farmers and researchers

As the examples cited at the beginning of this article show—and many others could be offered—a frequently stated belief is that farmers should have the dominant role in planning, conducting and evaluating research. This means not only when setting basic priorities, but also for individual projects: the topics should be chosen according to farmers' preferences; farmers should be heavily represented on advisory groups that steer the projects while in progress; and the projects' value should be measured mainly be farmers' answers to the question "How valuable was the work for you?"

Such generalizations do not allow for the many kinds of activities, serving many different purposes, that are encompassed under the term "research." Nor does it leave much room for the other constituencies who support publicly funded agricultural research, and therefore might feel entitled to benefit from it and to have a say in shaping it. Similarly, it does not allow for research planning on a scale larger than the individual project, which is necessary for a suitable mix of long-range and short-range, basic and applied, and component and system-level research. Lastly, it does not allow for differences in the way that farmers and researchers might look at the same question. Their viewpoints are different, and properly so. Ideally, a well-conceived research project will not simply seek a self-contained answer to a specific question, but will try to add to a cumulative body of knowledge that eventually can answer a broader, more general question. Thus the role of researchers is not merely to provide the technical expertise needed to answer specific questions posed by individual "clients." Do we really want researchers whose conception of their work is "Just tell us what should be done, and we will do it or help you do it."? If so, who is the "you" to whom researchers should be so obliging?

We have gotten into serious trouble in the past precisely because agricultural researchers were too ready to subordinate broader social considerations to the

short-term needs of specific client groups and saw their task primarily as supporting technical development. No matter that the problem was once that their clients were "corporate farmers," or "big rich farmers who exploit farm workers and are driving the family farmer out of business," or "agribusiness interests," whereas now it is the more deserving "sustainable farmers." The point is the same: research has something to offer beyond meeting the immediate, short-term technical needs of any one group.

When researchers welcome farmer involvement in research, they are reversing an unhealthy exclusivity that has condemned some research areas to remain sterile and meaningless. But beyond some point, they are abnegating their professional responsibility. To have one group call all the shots clearly is not the key to a socially desirable research system. It is wrong for researchers to claim an exclusive right to do so, and it is just as wrong to confer this right on farmers, whether "sustainable" or any other kind. Farmers and researchers have different purposes, different kinds of experience, and different relationships to agriculture. Neither can do the job alone, but if they are allowed to complement each other, both can make an important contribution to promoting true agricultural sustainability.

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INSTITUTE NEWS

IAA's new Occasional Paper Series examines on-farm research

"On-Farm Research Techniques," the first in the IAA's new Occasional Paper Series, is a report from a workshop organized last November to discuss how on-farm research can contribute to minimizing farming-related environmental and social problems. As interest in research on alternative agricultural systems has increased, disparate ideas have emerged about what on-farm research can accomplish, when it is appropriate, and how to do it properly. In addition to reviewing research techniques, this paper examines such important issues as farmers' research versus researchers' research, on-farm activities that complement research, appropriate choices of farms to be studied, collaborations among many groups of people with diverse interests, and barriers to acceptance of on-farm research.

The report was prepared by Molly D. Anderson and William Lockeretz of the School of Nutrition at Tufts University, Medford, MA. Copies are available for $6 from IAA, 9200 Edmonston Road, #117, Greenbelt, MD 20770; (301) 441-8777.

Food prices don't reflect true costs, speaker tells IAA symposium

The true costs of the U.S. food system are not reflected in the price of food, keynote speaker David Orr told participants at the March 5th IAA symposium held in Washington, DC. Orr, a political scientist from Oberlin College in Oberlin, Ohio, cited the difference between price and cost by explaining that "cost is not measurable. It includes things we ignore, things we don't realize are important until they are gone."

There are several immeasurable costs of food, he said: environmental

costs; the loss of rural communities; the cost of democracy and the need for a class of landowners; the cost of political instability; the cost of human health; and the cost of attachment to the land's future.

"We have not been well served by economics, which tells us only prices are real and that technology can overcome the limits of nature," Orr said in explaining why the true costs of food are not reflected in prices. "The land grant system has not been as open or hospitable to alternative agriculture as it should be. And there has been massive political failure."

In order to align cost and price, Orr recommended policies such as rewarding the production of food, ending the subsidization of overproduction, and adopting an accounting system that includes the price of natural capital. "Policies must make the distinction between growth and development, between obesity of economy and prosperity," he said. He also called for a national policy to rebuild rural America and to encourage regional self-reliance.

Health risks not reflected in cost of food

Health risks and food-borne diseases are additional costs that are not reflected in the price of food, economist Carol Kramer told the IAA symposium. Those costs are food safety problems, nutritional problems, and occupational safety and health problems, said Kramer, an economist with Resources for the Future in Washington, DC. The costs to society of food-borne disease are "inestimable" and are the result of incorrect information, information that is withheld from the consumer, and an imperfect market, she said.

Agricultural systems are part of natural systems

"We must think of agricultural systems as part of larger natural systems and ecosystems," according to wetlands biologist Dan Willard of Indiana University in Bloomington, Indiana. Addressing the IAA symposium, Willard described three case studies in the Soviet Union, California, and South Florida in which agricultural water projects had severely disrupted neighboring wetland ecosystems at the same time they did not help agriculture as much as promised.

The papers from the symposium will be published in a forthcoming issue of the *American Journal of Alternative Agriculture.*

DeWitt elected President of IAA Board

Dr. Jerald DeWitt, Associate Director of Extension at Iowa State University, was reelected to a second term as IAA President at the Board's March meeting in Washington, DC. Jim Bender, a farmer from Nebraska, was named Vice President; Dr. Katherine Clancy, of Syracuse University, was named Treasurer; and the Honorable Robert O. Blake, Washington, DC, was named Secretary.

The Board reviewed Institute long-range and strategic programmatic and institutional plans and activities. The Institute's 1992 symposium will focus on the potential contributions of alternative farming systems to the viability of small rural communities. The Board also decided to hold its biannual meeting in Ames, Iowa, in early September in connection with the Dick and Sharon Thompson Annual Farm Field Day.

New Board members seated at the meeting include: Paul Johnson, a farmer from Decorah, Iowa; Dr. Anne K. Vidaver, Chairperson, Department of Plant Pathology, University of Nebraska at Lincoln; and Dr. Eugene W. Adams, Professor Emeritus, Tuskegee Institute, Tuskegee, Alabama.

IAA President's Council named

Dr. Jerald DeWitt, IAA President, has announced the members of the President's Council for 1991. Members are: Charles Benbrook of Dickerson, MD; Norman Berg, Soil and Water Conservation Society; Bob Bergland, National Rural Electric Cooperative Association; U.S. Rep. George E. Brown, Jr., of California; Lester Brown, Worldwatch Institute; Ron Ellermeier, farmer from Nebraska; John C. Gordon, Yale University School of Forestry and Environmental Studies; Robert Gray, Resource Consultants; Ralph Grossi, American Farmland Trust; R. Jim Hildreth, Farm Foundation; Dana Jackson, The Land Institute; Dennis R. Keeney, Leopold Center, Iowa State University; Fred Kirschenmann, Kirschenmann Family Farms, North Dakota; U.S. Sen. Patrick J. Leahy of Vermont; Dan Martin, MacArthur Foundation; William Marshall, Pioneer Hi-Bred International; Ned S. Raun, Winrock International; Ronald L. Rosmann, farmer from Iowa; R. Neil Sampson, American Forestry Association; Richard J. Sauer, National 4-H Council; Edward Sills, Pleasant Grove Farms, California; Karl N. Stauber, Northwest Area Foundation; David G. Topel, Iowa State University; and Stephen Viederman, Jessie Smith Noyes Foundation. The Council was formed last year to provide guidance and support for Institute activities in promoting a more sustainable agricultural system in the United States and abroad.

EPA investigating pesticide research lab

The Environmental Protection Agency announced last month that it is investigating allegations that a Texas testing lab deliberately understated the residues of at least 17 pesticides used on fruits and vegetables. Research at Craven Laboratories, Inc., paid for by pesticide manufacturers, has been used by EPA to determine the pesticide levels allowed in fresh and processed foods. EPA is trying to determine how many pesticides on the American market were registered on the basis of studies conducted by Craven Laboratories. Despite the alleged fraud, EPA officials say that preliminary findings indicate no risk to the public health.

Meeting the challenges to agricultural research and extension

Richard Sauer

Abstract. *The public agricultural research and extension system has provided the foundation for great improvements in U.S. agricultural production. However, our incomparable productivity has brought with it serious problems. These problems have also led to a rapidly changing perception about both agricultural scientists and today's conventional agriculture. Critics are placing high on the agenda of the agricultural research and extension establishment the need for alternative technologies that are more sustainable and less exploitative of our resources. The growing demand for alternative systems offers challenges for every part of the establishment--research and extension administrators, branch station/research center directors, and faculty. These challenges and how they should be met are discussed. Alternative systems will become the conventional agriculture of tomorrow.*

Key words: agricultural research, agricultural extension, alternative agriculture, criticisms of current research/extension

Introduction

The sustainable and alternative systems emerging today will become the conventional agricultural systems of tomorrow; agricultural research and extension have no choice but to acknowledge the inevitability of that change and to respond constructively. I say this having spent most of my career as an agricultural scientist and administrator at land grant universities, most recently as director of a state agricultural experiment station.

We agricultural scientists in USDA and the land grant universities spent much of the 1980s celebrating past successes. There was considerable justification for our pride during that decade, which included both the centennial of the Hatch Act and the 75th anniversary of the Smith-Lever Act. More than a century ago, the public agricultural research and education system was given the job of developing scientifically based technologies to improve the productivity of U.S. agriculture. New technologies, coupled with the substitution of capital for labor and the use of inexpensive energy, freed labor to develop the country's industrial capacity, with impressive results. The land grant universities, with their agricultural experiment stations and extension services, in collaboration with USDA, laid the foundation for great improvements in U.S. agricultural production, literally making two blades of grass (or wheat or corn) grow where one grew before. They allowed the U.S. to become the world's largest exporter of food and fiber and a major provider of food aid, literally keeping millions of people alive overseas. Moreover, techniques borrowed from us have fueled the green revolution in Third World countries, staving off hunger and starvation

Problems and changing perceptions

But this success has had its costs, and our incomparable agricultural productivity has brought with it several serious problems. Some involve physical resources and the environment: eroded soils, with the related problems of heavy silting, increased flooding, and pollution from runoff; an alarming depletion of aquifers (sometimes to produce surplus commodities for which there is no market); disturbingly pervasive contamination of the environment by chemicals, especially in our water supplies; widespread resistance of insects and weeds to pesticides; and destruction of forests. Others are economic: costly surpluses created by policies that favor production for production's sake, regardless of the market; a decline in farm exports; and increased production costs that mean the U.S. may no longer be the world's cheapest producer of grains and oilseeds.

These problems have led to a rapidly changing perception of agricultural scientists' value to society (Johnson, 1983; Bonnen, 1986). The public's attitude has shifted from unqualified support to questioning ambivalence, and even to fear of the consequences of agricultural science. To understand the change in perception we need to hear and understand what the critics are saying about the agricultural research establishment. This is essential for making objective recommendations on agricultural science policies, introduction of new technologies, and priorities for research projects and extension programs.

According to Bonnen (1986), the criticisms come from several groups:

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Richard J. Sauer is President and Chief Executive Officer, National 4-H Council, 7100 Connecticut Avenue, Chevy Chase, MD 20815.

--Biological and physical scientists outside the land grant system who argue that agricultural science lacks a strong basic science foundation and is a third-rate enterprise that uses too many of its resources on applied research (resources that the critics would like to have some of);

--Those who are dissatisfied with the way that technological advance sometimes restructures agriculture and society;

--Humanists, social scientists, and religious leaders who maintain that the agricultural research and extension establishment pays inadequate attention to rural poverty and rural communities, human nutrition and malnutrition, endangered species, environmental pollution, and limited resources such as water and energy;

--Activists who sacrifice objectivity (at least that is how we rationalize not having to accept their criticisms) to promote solutions outside the domain of research.

These groups have succeeded in placing important issues on the agenda of the agricultural research establishment, especially the need for technologies that are more sustainable and less exploitative of our resources. Society has insisted that agricultural research be concerned with the effects of technology on the health and safety of producers, the nutrition and health of consumers, the aesthetic value and productivity of the environment, and the quality of life in rural communities.

Alternative agriculture: Fad or future?

It would be tempting for the agricultural research establishment to regard the call for an alternative agriculture that meets these criteria as merely a passing fad or just the concern of some offbeat activist group. Those who believe this should read the report entitled *Alternative Agriculture*, published in 1989 by the National Research Council (Pesek et al., 1989). (I am afraid that too many of my former colleagues at land grant universities have not read it.) The committee that prepared this book consisted of 17 prominent scientists representing almost the entire range of agricultural science disciplines, under the chairmanship of John Pesek, Head of Iowa State University's Agronomy Department and former president of the Soil Science Society of America.

Working with an open mind and dispassionate objectivity, the committee produced a balanced report that cautiously endorses a range of alternative farming systems (Youngberg, 1989). The report documents how problems with conventional agriculture have lead many farmers to adopt alternative practices to reduce input costs, conserve resources, and protect human health. Sometimes these alternatives have been based on the farmers' own trial-and-error research. Working with little or no help from the agricultural research and extension establishment, some of these farmers have been very successful, although others have failed.

More significant than the conventional practices that alternative farming rejects are the innovative practices that it includes. Alternative systems deliberately take advantage of naturally occurring beneficial interactions among the farm's components. These systems emphasize management, biological relationships, such as between pests and predators, and natural processes, such as nitrogen fixation. In assessing these systems, the NRC committee reached four major findings.

--In most sectors of U.S. agriculture, some farmers are now using alternative systems; the components of these systems are used even more widely. Farmers who have successfully adopted them generally gain significant economic and environmental benefits, and wider adoption would result in even greater benefits for the nation.

--Many federal actions significantly influence farmers' choice of practices. These include commodity programs, trade policies, research and extension programs, food grading standards, pesticide regulation, tax laws, and policies on the supply and quality of water. Often they work against environmentally benign practices and the adoption of alternative systems, giving less priority to resource protection than to a plentiful food supply.

--A systems approach is essential to the progress of alternative agriculture. Agricultural researchers have made important contributions to many components of both alternative and conventional agricultural systems. These include high-yielding cultivars, soil testing methods, low-input grain production methods, conservation tillage, and integrated pest management. However, little research has been directed toward the interactions important to alternative agriculture, for example among crop rotations, tillage, pest control, and nutrient cycling. This has meant that the scientific knowledge and management skills necessary for widespread adoption of alternative agriculture are not widely available.

--Innovative, risk-taking farmers have developed many alternative methods, largely on their own. These systems need to be studied further, and other farmers need this information to develop new management skills.

The growing demand for the alternative systems that the NRC report describes offers challenges for every part of the agricultural research and extension establishment.

Challenges for agricultural research and extension

Scientists in research and extension should admit that there are others, including farmers, independent researchers, and dabblers, who know more than they do about some alternative systems. In fact, some of these people may even understand conventional systems better because they have integrated alternative and conventional practices. Scientists should visit these farms, listen to the farmers, and conduct further research on the systems they are using. On-farm research and demonstration is a good way for other farmers in the area to learn about the alternatives that innovators have pioneered. However, very little research has been conducted on private farms, let alone by farmers. Professional agricultural scientists generally feel that most farmers lack the training required to conduct high-quality research and that research conducted on a farmer's field is subject to too many uncontrolled

variables because it is not closely supervised by professionals.

Branch station and research center directors and scientists should start conducting long-term research on alternative systems. This work should be done on plots that have and have not received heavy chemical applications. The former will show farmers what will happen when they shift from high-input conventional systems. The latter will remove the residual effects of pesticide and fertilizer carry-over.

Research administrators need to reorganize their institutions to do interdisciplinary team science (Sauer, 1986). The organization and funding of science is still tied too strongly to the 19th century tradition of the individual scientist surrounded by a few laboratory technicians or graduate assistants. Not all new technology arises from basic disciplinary research. Many of today's scientific problems, such as understanding the interactions among an agricultural system's components, can be solved only by the combined expertise of a team of scientists from various disciplines. Some of these problems are not just technological, but also require social, economic, and political analysis. The advice of farmers is also needed in setting research priorities, especially farmers who are testing the cutting edge alternatives.

Land grant university faculty and administrators must become actively involved in agricultural policy development. The U.S. needs sane, constructive, and complementary policies in agriculture, natural resources, and rural development. The importance of such policies is heightened by developments in the international economy, problems in rural America, the increasing number of critics of current policies, and the need for incentives (or at least removal of disincentives) for wider adoption of alternative farming systems. These policies must be based on scientific and technical knowledge, using the skilled professionals in our land grant universities and other public and private institutions. However, our policies often have been developed amateurishly in response to intense political pressures of special interest groups. Land grant universities have the people who can provide informed analyses of draft legislation or propose better legislation. However, these people have not been involved in these activities as much as they should have been, in part because they may consider them to be incompatible with being impartial and scientifically objective.

Extension must respond to the political, budgetary, institutional, and societal pressures it has been increasingly subjected to in the past two decades. Its continued value, and even its very existence, are being seriously questioned, with the main criticism being that it has not been able to achieve consistent, predictable results in local communities (Meyers and Pigg, 1989). Its first response was to be defensive, but as pressures mounted, the response became "Issues Programming." This meant drawing on local groups in identifying priorities and developing interventions, with programs evolving as external needs changed. However, this important difference in procedure has not taken place in most states. Some extension staff and administrators have used "issues programming" as just another name for their previous planning methods, but others at least have required a multidisciplinary or interdisciplinary approach. Some use "issues programming" as a public relations device to improve extension's image, with no substantive change, but others understand that effective programs require political resolution of the issues. Extension needs to deliver programs relevant to community issues where the needs are greatest. Instead, it concentrates on needs that were the greatest. For example, it still emphasizes conventional agricultural technologies, even though the greatest need is to foster widespread adoption of alternative agricultural systems. Extension must do more than disseminate information and teach new skills: it needs to empower its clientele to solve community problems by putting what has been learned into action. And extension must become involved in community action, allying with local citizens in influencing lawmakers and developing policies. If it does allow local communities to decide which issues deserve priority, it will begin to work proactively with the pioneers of alternative agriculture.

Research and extension administr
tors must make tough choices, curtaili
or even eliminating some old prograr
to make funds available for newer pr
grams that are needed more. Too oft
they just lament that existing funds ar
people are already spread too thin
allow them to take on additional pr
grams without additional money. B
public money, whether federal, state,
county, is becoming harder to obtai
The system must be made more flexib
to allow money to be reallocated
issues-based programming, which so f
has not received significant funding.

Finally, we all should be thinkir
about the next generation of farmers. E
tension and the land grant universiti
have at their disposal an effective mea
both to change farmer behavior and
improve the knowledge and skills of th
next generation: 4-H, the nation's large
and most successful youth developme
education program. Seventy-five yea
ago, boys' corn clubs (the first 4-H club
were started to get farmers to adopt th
new varieties. This change in the beha
ior of adults, accomplished by youth
had an enormous effect on U.S. agricu
ture. Today we should be trying to infl
ence adult behavior concerning mo
sustainable agricultural practices. Yout
could help extension in bringing abou
this change. Subject matter extensio
specialists, working with 4-H staf
should be designing new 4-H agricu
tural curricula that demonstrate and en
courage early adoption of new techno
ogies. Agriculture's future as a progre
sive industry will depend on its ability
compete in world markets. Early innov
tors will capitalize on changes to mak
themselves more competitive and su
tainable. In 4-H we have a unique pr
gram to help us to achieve this, and w
should be using it.

The problems of the future in agricu
ture and rural America cannot be solve
by the research and extension program
of the past. We need major changes i
the research agenda, in the organizatio
and funding of research and extensio
programs, and in the mix of scientis
and educators who will carry out thes
changes. Research and extension will b
driven by new priorities: sustainabilit
environmental quality, human healt

consumer preferences, and the well-being of rural communities and society as a whole, as well as the traditional priority of productivity. Addressing these concerns will involve ethical considerations and will require that societal values be incorporated into decisions about research and the development and transfer of technology.

The systems that today we call alternative will become the conventional systems of the 21st century but will continue to evolve. To accommodate these changes, we agricultural scientists must see ourselves as partners in a complex agricultural production system, to which we contribute, but from which we also learn. Indeed, we will be able to contribute more the more we listen and learn from others, especially those pioneering farmers who have dared to be different. If we choose not to listen and learn, we are doomed to irrelevance.

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BOOK REVIEWS

Sustainable Agriculture in Temperate Zones. 1990. Edited by Charles A. Francis, Cornelia Butler-Flora, and Larry D. King. John Wiley and Sons, Inc., New York, New York. 487 pp.

Described on the dust jacket as "an exhaustive review of the best thinking on the future of agriculture," to a substantial degree this book earns that description. This collection of 16 chapters, authored by 23 contributors is, more than other recently published works on the subject, a cohesive and readable account of agriculture as envisioned by the "alternative agriculture movement." Certainly most of the contributing authors are *bona fide* leaders in that movement, as well as qualified scientists or farmers.

The editors selected topics and contributors to provide both breadth and depth. Nonetheless, omissions or imbalances are evident. Other than 2.5 pages in the chapter on the Thompsons' farm, there is no in-depth coverage of livestock management (including animal welfare). This, despite numerous references to the importance of livestock in sustainable agriculture (SA). Other topics inadequately covered include soil erosion (1.5 pages in chapter 5) and urbanization of agricultural land (hardly mentioned), two major threats to the sustainability of agriculture in temperate zones. Also, readers concerned with food safety and quality (a major issue behind public interest in SA) will find little on fruits and vegetables. The book has a decidedly agronomic (grain and forage crops) bias. These weaknesses could have been corrected without lengthening the book simply by eliminating the introductory and concluding chapters and replacing them with material on these subjects.

Each chapter includes a list of references, some providing an excellent bibliography on an aspect of SA. Many references are as recent as 1990. In addition, there are overall subject and author indices, a real boon to the researcher or student. Also, for the most part, the chapters are well cross-referenced.

The book begins with a brief preface which sets the tone and provides a working definition for SA. Chapter 1, "Sustainable Agriculture--An Overview," by Charles Francis of the University of Nebraska and Garth Youngberg of the Institute for Alternative Agriculture, then previews the main points from each chapter.

Chapter 2, by Francis, is entitled "Breeding Hybrids and Varieties for Sustainable Systems." The wording of this chapter title is interesting, given that there are people who question the use of hybrid seed from sustainability and food quality points of view. This question is not addressed by Francis, and one wonders whether the chapter title is an indirect way of dismissing the relevancy of the question. This point aside, Francis makes an eloquent appeal for plant breeders to look at least 10 years ahead to determine what needs their programs should be designed to meet. He then discusses designing breeding programs especially for low-input sustainable systems. In doing so, Francis posits the assumption, questionable to this reviewer, that low-input systems equate to stress environments.

In chapter 3, "Design of Pest Management Systems for Sustainable Agriculture," George Bird and Tom Edens of Michigan State University and Frank Drummond and Eleanor Groden of the University of Maine give a broad, systems-based presentation of pest management models, including a

clear and concise outline of the principles of systems science and its uses in designing sustainable farming systems. Somewhat anecdotal case studies are used to illustrate successful systems on real farms.

As the title suggests, chapter 4, "Sustainable Weed Management Practices," contrasts with chapter 3 in that it emphasizes a compendium of practices without giving much attention to an overall framework of principles. This emphasis may reflect the state of the conceptual framework in weed science as opposed to entomology. The excellent discussion of the role of crop rotations presents the closest thing to a set of guiding principles that can be found. The authors, Matt Liebman of the University of Maine and Rhonda Janke of the Rodale Research Institute, present many good examples of integrated weed management, though most of the information is anecdotal and the systems are not presented in as much depth as one would like. One suspects that repeated citations of "recent research suggests" actually refer to current work of the authors and wishes that they had presented some of the data, even if preliminary.

Chapter 5, "Sustainable Soil Fertility Practices," written by Larry King, North Carolina State University, focuses on nitrogen and phosphorus cycles and the need to minimize losses from them, while also replacing what is removed in the harvested crop. Although the chapter takes a balanced approach to organic and inorganic fertilizers, the potential role of recycled wastes such as sewage sludge for replacing nutrients lost from the farm is somewhat understated by citing gross national figures suggesting that only 1.6 to 4 percent of U.S. cropland would be needed to receive all the sludge produced in 1985. This estimate was based on an average nitrogen loading of 112 kg/ha, which may be average for corn land but certainly not for "all U.S. cropland." Most U.S. cropland is too far from urban sources of sludge to be economically treated anyway, but in regions such as the northeast, sludge may be a very important source of nutrients in the future.

In chapter 6, "Legumes and Crop Rotations," James Power of the University of Nebraska starts with the basics, including a very lucid explanation of how the biological nitrogen fixation (BNF) process works and contributions that legumes make to associated non-legume crops. Data from many sources are presented to substantiate these points. Unfortunately, the concluding remarks are not very optimistic in that they assume the continued separation of livestock production from crop production, and therefore the limited applicability of long-term rotations with forage crops.

The chapter by John Doran (USDA-ARS) and Matthew Werner (University of California, Santa Cruz) entitled "Management and Soil Biology" presents information on topics usually overlooked by general monographs or standard textbooks. It discusses both soil fauna (e.g. arthropods, earthworms) and microorganisms and how they interact with production systems. In tone, this chapter has a distinct anti-agrichemical bias, though the authors present several studies showing net beneficial effects from use of these materials (e.g. "benefits from...reduced tillage exceeded detrimental effects of chemical use"). The authors present a creative review of the literature and call into question some commonly held "truths" concerning soil biology. For example, the authors conclude that soil faunal and microbial diversity may be reduced rather than increased by rotating crops instead of growing them in continuous monoculture. They also make it clear that we have much to learn before we can understand and manage the "synchrony between release of N and other elements from organic sources and the growth requirements of grain crops."

The chapter on "Pasture Management" by Bill Murphy of the University of Vermont brings to light what is surely one of the greatest potentials for increasing agricultural productivity and profitability in a low-input, sustainable manner. The current mismanagement and under-utilization of pasturelands in the U.S. is scandalous. Murphy describes intensive pasture management using both general princi ples and practical details. He begin with basic principles but flounders a bi in a hard-to-follow discussion of swar dynamics. The rest of the chapter ha a more advisory style with such ke statements as: "Our primary concer must be to take care of the plants an soil. The animals' needs will be met b the improved soil conditions and plan production...."

Farm couple Sharon and Dic Thompson have teamed up with Iow State University Agricultural Econo mist Derrick Exner to write chapte 9, "Case Study: A Resource Efficien Farm with Livestock." The Thomp sons' 125 hectare farm has receive much publicity for its adaptations suc as anti-biotic and hormone-free live stock feeding, ecologically and ethno logically sound hog housing, ridge till age without herbicides, cover crops and manure and sludge handling sys tems. The editor's disclaimer to th contrary, this chapter is as well refer enced as other chapters of simila length (e.g. chapter 12) with 21 refer ences, many of them technical. It ha a welcome, fairly detailed (2.5 pages account of the livestock operations an their integration into the whole farm ing system. Considerable detail is also given on the economics of the various enterprises. Use of 1989 data represents a considerable update on a similar case study in the 1989 NAS report which used 1987 figures. The last section o the chapter addresses the question o how farms can become more sustain able without integrating animals an the role of government price support in determining profitability.

"Converting to Sustainable Farming Systems" is the subject of chapter 1 by Rebecca Andrews, Rhonda Janke and Steve Peters of the Rodale Research Institute and Warren Sahs of the University of Nebraska. Both institutions have conducted, during the past decade, long-term comparisons between organic and conventional grain farming systems. There is sufficient detail and data on the experiments to provide a real contribution, even if these results are published in research papers elsewhere. The authors suggest tha

farmers deciding to convert to sustainable systems face "biological, managerial, informational, socio-economic and political barriers" to successful adoption. The chapter, however, is devoted almost entirely to the biological barriers.

Patrick Madden, who writes chapter 11 on "Economics of Sustainable Low-Input Farming Systems," is the only author with no institutional affiliation identified. Madden was a Professor of Agricultural Economics at Pennsylvania State University and has been largely responsible for the national administration of the USDA LISA grants program. In addition to providing a firsthand progress report on that research grants program, Madden also provides an objective review of past survey studies. He concludes that at least some commercial-scale farmers are making profits from organic or low-input systems similar to the profits earned by comparable conventional farms. The observation is also made (as in other chapters) that government commodity programs intended to reduce the production of certain commodities have instead encouraged systems that emphasize these commodities and discourage more environmentally benign systems. The chapter reflects the lack of hard data on the profitability and macroeconomic impacts of sustainable systems in the U.S. Disappointingly, Madden has not attempted here to begin to fill this void with a study of his own.

Chapters 12 and 13, by Virginia Tech Sociologist Cornelia Butler-Flora, are intended to cover the socio-political aspects of SA. While these are extremely important topics, especially in light of the agronomic-technical emphasis of the rest of the book, the coverage in these chapters is not as in-depth and rigorous as one might hope. Much of chapter 13, "Policy Issues and Agricultural Sustainability," reworks topics covered in earlier chapters. Both chapters are written more as an outline than as an in-depth discussion. To this biological scientist, the treatment in chapter 12, "Sustainability of Agriculture and Rural Communities," seems highly speculative. Insufficient data are given to substantiate statements on such aspects as the rural community characteristics associated with sustainability. One undemonstrated assumption is that "Sustainable rural communities will have...mechanism (*sic*) to make capital available for non-agricultural development instead of the current situation of over investment in agriculture." This statement does not seem to be born out by data presented elsewhere in the book.

If chapters 12 and 13 consist largely of generalizations with little data, Wes Jackson has done the opposite in chapter 14, "Agriculture with Nature as Analogy." This chapter details the futuristic, rather unconventional work of Jackson and his associates at The Land Institute in Salina, Kansas. The ultimate goal of the work is to develop a perennial polyculture of grasses, composites, and legumes that can produce seed (grain) for human use while mimicking the homeostasis and resource conservation of the native prairie ecosystem. The chapter is uneven in style, as it alternates from broad philosophical principles to extended quotations from internal reports detailing where, when, and by whom various kinds of plants were grown. The chapter is built around four basic research questions. The first, "Can herbaceous perennialism and high seed yield go together?" is answered in the affirmative using extensive research results and numerous anecdotal observations. The answers to the others are not so definitive. Also poorly defined is the call to do research "using Nature as the standard."

William Lockeretz, in a thought-provoking chapter on "Major Issues Confronting Sustainable Agriculture," discusses five unanswered and often unasked questions in the penetratingly logical style that is his hallmark. The first of these questions is of particular relevance to this book itself as it asks: What are the differences between sustainable, alternative, low-input, organic, regenerative, etc? The other questions ask: Is SA just a matter of reducing inputs?; Does SA require fundamental changes in economic, institutional, and scientific paradigms?; Can we trust the establishment?; and Is SA harder than conventional agriculture?

The final chapter, by Francis, "Future Dimensions of Sustainable Agriculture," mainly reviews earlier chapters but does contain a well-organized list of challenges for researchers, extensionists, educators, and farmers.

In conclusion, the book's strengths certainly outweigh its weaknesses. It will provide a useful overview to the mainstream agriculturalist of what the concept of SA is all about. It will also serve, better than any other book of which this reviewer is aware, as a textbook for an upper-level undergraduate or graduate course on the topic. The book will provide a framework of concepts and sources of information for workers in the field and is bound to raise the level of thinking and discussion on issues vital to the future of agriculture. -- *Raymond R. Weil, Associate Professor, Agronomy Department, University of Maryland, College Park, MD.*

New organization addresses loss of genetic diversity

The Institute for Agricultural Biodiversity has been formed to address the problem of the escalating loss of agricultural genetic diversity. It will develop models of livestock preservation through training, research, interdisciplinary education, policy analysis, and direct conservation. The Institute is dedicated to developing the tools for practitioners and policymakers to initiate the critically important program of preserving whole breeding populations of livestock within the context of sustainable agriculture systems. Contact Shan Thomas or Hans Peter Jorgensen at the Institute, Rural Route 3, Box 309, Decorah, IA 52101; (319) 382-5947.

Abstracted by William Lockeretz

Research reports

Selenium uptake by some agricultural crops from central California soils. H. F. Wan, R. L. Mikkelsen, and A. L. Page. *Journal of Environmental Quality* 17(2):269-272 (1988).

This paper was motivated by the discovery of high selenium levels in drainage water from irrigation in the San Joaquin Valley. Elevated Se levels in plants may be toxic to humans, livestock, and wildlife. The study was undertaken to measure Se uptake by various crops grown on various soils and to determine its partitioning among different parts of the plant. The soils were from the Panoche Fan in the San Joaquin Valley, believed to be a major source of Se in irrigation and drainage waters.

In one experiment, Se was added to one soil (a loam) at levels to 1.5 ppm, in the form of selenate, which is readily available for plant uptake. Three crops consumed by humans (barley, beet, and tomato) were grown in pots, as was alfalfa at the same Se levels. Later the investigators discovered that this soil has a very high level of soluble sulfate (3088 mg/liter), which interferes with Se uptake. In the second experiment, alfalfa was grown in pots on four more soils with Se added at levels to 3.0 ppm. One of these soils also was high in soluble sulfate.

In the first experiment, no crops showed yield differences among the various Se levels. The edible portions of the first three crops (barley grain, beet root, and tomato fruit) were all lower in Se than the remainder of the plant. For all crops and all plant parts, Se content increased with increasing amount of Se added to the soil. The highest observed level in an edible portion was 22 ppm in barley grain (at 1.5 ppm added Se); the highest level in any portion was 77 ppm in tomato leaves.

Alfalfa dry matter production (roots and shoots) decreased sharply with increasing soil Se in the three soils that were not very high in soluble sulfate. At the highest level, yield almost vanished. For all five soils, Se uptake increased with increasing soil Se level but was much higher for the three soils low in sulfate. The highest level was 3185 mg Se per kg of soil in second-cut alfalfa for one soil. The concentration was always higher in the shoots than the roots. At each level of added Se, plant uptake from different soils decreased sharply with increasing level of soil sulfate. The authors noted that in this experiment the edible crops were grown only on a high sulfate soil, so that even higher levels might be observed in other soils. Even so, the levels were potentially harmful. For the low sulfate soils, Se levels in alfalfa were extremely high, well above the toxic level and high enough to reduce yield.

Effect of biocidal treatments on cation exchange capacity and Fusarium blight of soybean in Delaware soils. H. A. Sandler, R. B. Carroll, and D. L. Sparks. *Agronomy Journal* 80:8-12 (1988).

This study examined how sterilization of soil affects the severity and incidence of Fusarium wilt of soybean, and also determined its effects on several soil parameters that can influence whether a soil is suppressive or conducive for this disease. Fusarium wilt is a serious disease of soybeans in Delaware and many other growing areas, reducing yield by up to 59 percent on the Delmarva peninsula. Fumigation has achieved only limited control. However, certain soils are naturally suppressive; that is, the disease does not develop even when the pathogen is introduced and a susceptible host plant is present. The relationship between suppressiveness and soil characteristics is very complex and far from completely understood. Sterilizing some soils increases disease severity if a soilborne pathogen is then introduced.

This experiment involved five Delaware soils, including one that is suppressive and one that is particularly conducive for Fusarium wilt. Biocidal treatments included autoclaving, fumigation with Vapam, and an unsterilized control. After each treatment, soil samples were left uninoculated or were inoculated with a strain of *Fusarium oxysporum* that is pathogenic to soybeans. A variety of soybean that is highly susceptible to this pathogen was grown in pots in a greenhouse on samples of soil receiving each treatment.

The biocidal treatments had highly variable effects on the five soils' chemical properties. Cation exchange capacity (CEC) generally was increased by fumigation, but in some soils it was unaffected and in others it decreased. Generally, autoclaving decreased CEC, but here, too, the effect was highly variable. Sometimes the two sterilization methods affected CEC in the same direction, sometimes opposite. Also, the effects of sterilization varied with the pH at which the measurement of CEC was made. The two sterilization treatments tended to increase soil organic matter and lower pH, but there were many exceptions. The authors note that the effect on organic matter may result from a change in the rate at which organic matter is oxidized.

Both the incidence and the severity of Fusarium wilt varied strongly with soil type and treatment, in both the inoculated and uninoculated soil samples. The effect of both autoclaving and fumigation could go in either direction, and only in some cases were the results similar between the two treatments. Likewise, results were not always consistent between inoculated and uninoculated samples of the same soil type for the same treatment. For some soils and treatments it was possible to relate change in disease status to changes in chemical properties, but no relationship was observed in other cases.

The authors conjecture that sterilization may affect Fusarium by altering the soil organic matter content, which in turn affects other soil characteristics. They suggest that organic matter therefore serves as a link between the chemical and microbial components of the soil. They note, however, that the interactions between soil, plant, and pathogens are highly variable. Therefore, each situation must be examined individually to determine how biocidal treatment affects the soil's ability to suppress Fusarium wilt.

Alfalfa dry matter and nitrogen production, and fertilizer nitrogen response in legume-corn rotations. O. B. Hesterman, C. C. Schaeffer, D. K. Barnes, W. E. Lueschen, and J. H. Ford. *Agronomy Journal* 78:19-23 (1986).

Economic comparisons of crop rotations including alfalfa, soybean, and corn. O. B. Hesterman, C. C. Schaeffer, and E. I. Fuller. *Agronomy Journal* 78:24-28 (1986).

These two papers are based on a two-year study at four experiment stations in Minnesota in 1982 and 1983. The study's main purpose was to compare two types of alfalfa and two different harvesting schedules with regard to nitrogen accumulation, forage yield and quality, and yield and nitrogen requirements of subsequent crops. One alfalfa cultivar was a moderately dormant type; the other was an experimental, non-dormant type that is not winter hardy, and therefore must be grown as an annual under Minnesota conditions. One harvesting schedule involved three cuttings in the seeding year; in the other, there was only one cutting, with regrowth incorporated in the soil. Besides alfalfa, corn (at 5 rates of N fertilizer) and soybeans were also planted in the first year, and all treatments were followed by corn in the second year, also at 5 N rates.

The two alfalfa varieties were comparable in dry matter production, but the non-dormant variety resulted in more N incorporated into the soil under both harvest systems. However, the difference between harvest systems was greater than the difference between varieties, with the one-cut system incorporating 83 percent more N when averaged over varieties and locations.

When no N was applied to the second-year corn, yields were significantly higher after alfalfa than after corn for all but one of the 16 combinations of variety, harvesting schedule, and location. Corn also generally yielded higher after alfalfa than after soybeans. The effect of a preceding alfalfa crop involved more than just N incorporation; in only one of four locations was there a significant correlation between corn yield and the amount of N incorporated under the preceding combination of alfalfa variety and harvest schedule. Corn following soybeans also yielded generally higher than corn after corn, but not by as much as corn following alfalfa.

Response of corn to fertilizer N varied with location. At one location, there was no response to N after any preceding treatment. At a second, corn responded to N after corn but not after soybean or any alfalfa treatment. At the other two locations there was a response after corn, but the response after alfalfa depended on the management of the alfalfa. Generally, corn either did not respond at all to N after alfalfa, or reached its maximum yield at a lower rate than after corn.

These results were used in an economic analysis of each of the preceding crop rotations and fertilizer rates under various crop and fertilizer prices. For all locations, the highest returns over cash costs occurred when corn followed three-cut alfalfa. At least one variety of alfalfa (and both varieties at three locations) as the first year crop resulted in higher profits than either corn-corn or corn-soybeans. Which of the latter two was next most profitable depended on location.

In three of the four locations, the winter hardy alfalfa variety was more profitable than the experimental non-dormant variety, mainly because it produced more crude protein and total digestible nutrients. This was more important than differences in the amount of N incorporated into the soil. Similarly, although the three-cut system resulted in less N incorporation than the one-cut system, and therefore greater fertilizer requirements, its greater hay production was more important in the overall economics of the rotation, and it consistently was more profitable than one-cut alfalfa.

Although alfalfa-corn was consistently more profitable than corn-corn, this was not necessarily because of lower fertilizer requirements in the following corn crop. In fact, at one location the optimal N rate in the second year was higher after alfalfa. As N price decreased, the optimal N rate in the most profitable system increased, of course. However, the most profitable rotation always included alfalfa, except for one location under a high price for corn and a low price for nitrogen.

The biological control of cassava mealybug in Africa. Richard B. Norgaard. *American Journal of Agricultural Economics* 70(2):366-371 (1988).

This paper is based on an evaluation team's report on a biological control program carried out by the International Institute of Tropical Agriculture, Nigeria, in the early 1980s. The control program was badly needed because of the severe damage being caused by the cassava mealybug, a recently introduced pest. Originally cassava was a South American crop, and when it was brought to Africa in the

17th century, its pests were left behind. Consequently, cassava was widely grown throughout sub-Saharan Africa without severe pest problems. However, in the 1970s the mealybug was inadvertently introduced from South America. Because it had no natural enemies in Africa, it spread rapidly; and in 1983 it reduced cassava production by an estimated 65 percent. This damage was particularly critical because cassava is a major component of the diet of subsistence farmers in many African countries. A parasitic wasp, *Epidinocarsis lopezi*, was found in South America and brought to Africa for mass rearing and distribution using techniques developed by IITA. By 1987 the wasp was established in 90 percent of the cassava growing region of Africa and brought the mealybug under control.

The author has attempted to calculate the cost-benefit ratio of this program. He notes that there are many difficulties in doing such a calculation accurately. Reliable statistics on cassava production are not available because it is often raised as a subsistence crop and because it is harvested a little at a time, as needed. Estimates of the yield losses caused by the cassava mealybug range from 10 to 100 percent, and estimates of the reduction in losses achieved by *E. lopezi* vary from 50 to 90 percent. Also, the price of cassava varies widely between years of good and of poor harvests. Finally, other changes, such as adoption of resistant varieties, would have reduced losses somewhat even without the biological control program. For these reasons, the author chose to estimate the cost-benefit ratio for a "reasonable, least favorable" case. He kept the analysis very simple, correctly noting that given the inadequacies of the data, a more elaborate analysis would not have been justified.

The calculation assumes gradually increasing losses from cassava mealybug (without the control program) starting in the late 1970s, to a peak of 20 percent in 1983, after which losses would have gradually declined even without the program. Biological control is assumed to cut these losses by an increasing proportion, to a peak of 60 percent in the late 1980s. All costs and benefits are discounted to 1981 values, using a 10 percent annual discount rate. Under these assumptions, the benefits (reduction in yield losses caused by the mealybug) would have a value of $2.2 billion, while expenditures by IITA and national institutions would come to $14.8 million. The cost-benefit ratio of 149 is, the author believes, a conservative estimate. Under various reasonable alternative assumptions, it would have been much higher; but the true value is not likely to be less than 100.

The author offers several explanations for the very favorable cost-benefit ratio. First, this case involved ideal conditions for classical biological control, because the control organism already existed in the original home of both the pest and the crop. Moreover, *E. lopezi* was found quickly and could be reared easily. In addition, it dispersed rapidly, established itself widely, and achieved good control under widely varying conditions. Also, the farmers did not have to do anything to control the pest, so there was no need for continuing support, i.e. credit, extension programs, or technological development. Although the circumstances here were very advantageous, the author believes that many other highly successful biological programs are possible for Africa, since many of its crops, like cassava, were introduced, and since very little effort has been expended on biological control so far.

Call for papers

INNOVATIVE POLICIES FOR AGRICULTURAL RESEARCH

Boston, Massachusetts, November 21-22, 1991

The diverse demands that farmers and the American public are placing on agriculture have stimulated innovative thinking about alternative research approaches. The current professional and institutional setting is not entirely conducive to these approaches. Changes are needed in how agricultural research is funded and organized, and how researchers are trained and rewarded, to foster a more resource-conserving and publicly-responsive agriculture.

We invite papers for a conference on policies to encourage alternative research and education strategies, including:

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- fulfilling the promise of interdisciplinary research
- taking advantage of the potential contribution of research institutions outside the USDA/Land Grant University system
- establishing constructive relations between the research profession and "outside" groups, such as environmental and farmers' organizations
- making the best use of diverse sources of research funding (state, federal, and foundation)
- educating future researchers who can respond to changing demands on agriculture

Papers may suggest future strategies, analyze current policies, or present a historical perspective. We especially encourage papers that apply to more than a single discipline, region or program.

Send abstracts of 300-500 words (2 copies) to William Lockeretz, School of Nutrition, Tufts University, Medford, MA 02155. Abstracts must be received by July 15, 1991. Notice of acceptance will be sent by August 12. You are welcome to call (617-391-1033) to discuss an idea for a paper.

Guide for authors

The American Journal of Alternative Agriculture (AJAA) publishes original research on biological, physical, or social science aspects of alternative agriculture. We particularly welcome multi-disciplinary studies, but papers from a specific discipline also are invited. However, since AJAA readership is much broader than for a single-discipline journal, highly specialized terminology should be explained or avoided. The significance of a statement, or the reasoning behind a conclusion, may have to be spelled out more than in a more specialized journal. See Vol. 5, No. 1, pp 2 & 3, for an explanation of the various categories of articles.

Units

Research papers should use the International (SI, or metric) system throughout. Occasional use of common unit equivalents in parentheses is permitted, mainly for relatively exotic SI units.

Title page

The title page should give the following information (all flush left): 1) title of the paper; 2) names of authors; 3) affiliation and office address of authors, and 4) acknowledgements, if any. See examples in this issue of AJAA.

Abstract

The abstract should be 200 to 400 words suitable for readers from a broad range of disciplines. It should avoid highly-specialized terminology that might be appropriate for a single discipline journal. Take particular care that the significance of the work is made clear, even to readers from a different field.

Key words

Provide subject matter key words suitable for use in scientific indexing.

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References should be listed in alphabetical order by author's name, and by year for a particular author (with letters after the year if needed). If a sole author is also the lead author of papers with multiple authors, use the following order: single author (by year); two authors (alphabetically by second author's name); three or more authors (by year). Repeat the author's name for each reference. Use initials only for first and middle names. Give the names of all authors in the reference; never use "et al."

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AJAA does not use bibliographic or substantive footnotes. All bibliographic references should be at the end of the text. Instead of substantive footnotes, include the material in the main text or consider eliminating it.

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The entire manuscript, including abstract and references, should be typed on one side of standard-size paper, double spaced, with margins of at least one inch all around. Starting with the title page, label all pages in the upper righthand corner with the lead author's last name and the page number. Do not use hyphens unless the hyphen is part of the word.

Follow the section headings style used in this AJAA issue. All headings are flush left, with no underlining or italics.

Tables should fit on one page, be numbered consecutively with Arabic numerals, and be on a separate sheet. Leave extra space to separate columns. Every figure and table should be mentioned at least once in the text.

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Submit four high-quality copies to Editor, American Journal of Alternative Agriculture, Suite 117, 9200 Edmonston Road, Greenbelt, MD 20770. The cover letter should state that the manuscript is an original contribution that has not been published elsewhere in substantially the same form; that it is not currently under consideration elsewhere, and that permission has been obtained for any copyrighted material used.

How you can help support the scientific and educational needs of a sustainable agricultural system

A growing number of Americans have become concerned about the long-term sustainability of our food production system. Farmers and agricultural scientists are among those raising questions about the growing dependence of modern farming on nonrenewable resources, the depletion of our resource base through soil erosion, and heavy reliance on chemical fertilizers and pesticides. Continued heavy reliance on farm chemicals is questioned because they have become an expensive production input. Their widespread use also raises questions about human and animal health, food quality and safety, environmental quality, and the continued demise of the family farm.

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